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# Trial Runs of the Pacific Liner Congress

The twin screw passenger and freight steamer *Congress*,* built for the Pacific Coast Company by the New York Shipbuilding Company, Camden, N. J., from designs by G. W. Dickie, naval architect and marine engineer, San Francisco, left the shipbuilding company's dock at Camden at 10 A. M. on Saturday, July 17, for her official trials. As the vessel was under charter to load a general cargo for San Francisco, it was found impracticable to load her to a mean draft of 22 feet 6 inches, as required by the specifications, so the trials were made with the vessel drawing 25 feet 4 inches aft and 15 feet 5 inches forward, with a displacement of 8,360 tons.

The Delaware Breakwater was reached late at night and the vessel was anchored until daylight, when a few hours were spent adjusting compasses. A progressive trial over the measured mile was then carried out, consisting of five double runs beginning at 10 knots and ending at 16.5 knots, from the results of which the speed, power and revolution curves were plotted. A run at full speed was then made out to sea for six hours and back again at a mean speed of 16.5 knots.

The *Congress* returned to the shipyard late on Sunday night,

FIG. 1.—TWIN SCREW PASSENGER AND FREIGHT STEAMER CONGRESS BUILT BY THE NEW YORK SHIPBUILDING COMPANY FOR THE PACIFIC COAST COMPANY

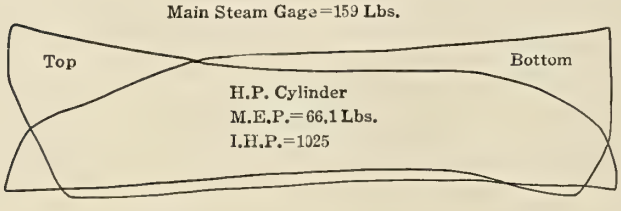
* For description, see page 283, INTERNATIONAL MARINE ENGINEERING, July, 1913.

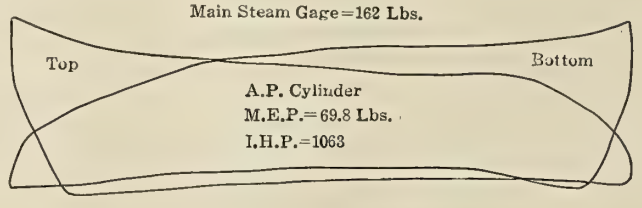
FIG. 2.—SECOND CLASS LOUNGE

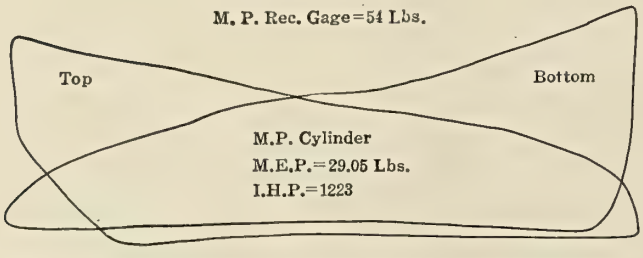
FIG. 3.—FIRST CLASS STATEROOM AND BATH

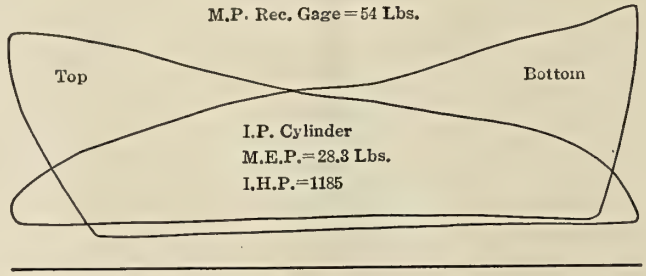
and on July 29 she was accepted by the owners and proceeded to the Port Richmond docks to take on a general cargo of 3,500 tons. The vessel then left Philadelphia with a mean draft of 27 feet 2 inches in fresh water, or 26 feet 4 inches in salt water, and began her long trip to the Pacific Coast, leaving the lightship at 10 A. M. Sunday morning, when the river pilot gave up charge to Captain H. C. Thomas, who is taking the ship around to San Francisco.

On the fourth day out the vessel touched at Trinidad to take on oil to replace the fuel burned en route. The four days' run to Trinidad gave ample opportunity to test the speed and power curves produced on the trials. At the start the revolutions were fixed by the curve for 12½ knots. It was found that the vessel exceeded that speed by from 6 to 9 knots a day, although the days were six or seven minutes short of the twenty-four hours, and the mean draft on trial was 19 feet



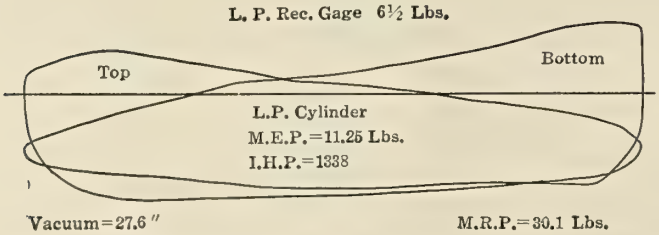




FIG. 4.—INDICATOR CARDS FROM PORT ENGINE AT 91.92 R. P. M. TOTAL HORSEPOWER, 3586

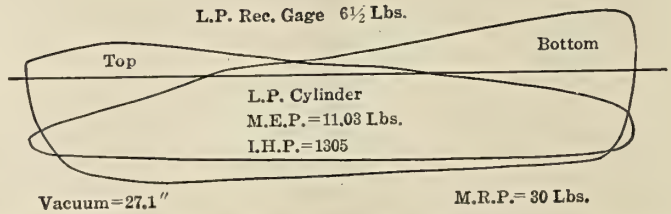



FIG. 5.—INDICATOR CARDS FROM STARBOARD ENGINE AT 91.93 R. P. M. TOTAL HORSEPOWER, 3553

FIG. 7.—BALL ROOM ON BOAT DECK

FIG. 9.—FIRST CLASS SMOKING ROOM

FIG. 6.—FIRST CLASS DINING SALOON

FIG. 8.—FIRST CLASS LOUNGE

10½ inches, while on the four days' run it was 26 feet 4 inches with about 3,000 tons more displacement.

The data obtained from the standardization trials are shown in Table I, while the speed, power and revolution curves are plotted in Fig. 10. Figs. 4 and 5 show a set of indicator cards (not full size) taken from the port and starboard engines respectively on the fifth run over the measured mile. At the time of the trials the sea was calm with a north wind blowing at the rate of four miles per hour. The weather was cloudy, and the temperature on deck 75 degrees Fahrenheit, with the barometer registering 29.84 inches.

The *Congress* is propelled by two sets of triple expansion

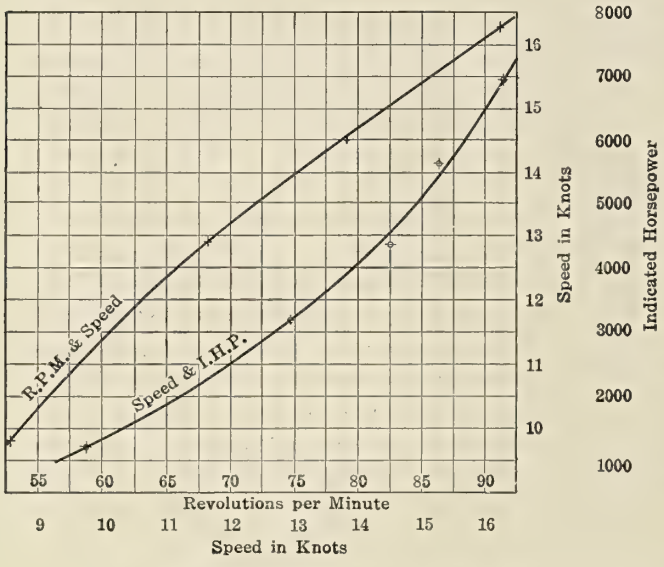

R.P.M. & Speed
Speed & I.H.P.
Speed in Knots
Indicated Horsepower
Revolutions per Minute
Speed in Knots
55 60 65 70 75 80 85 90
9 10 11 12 13 14 15 16
10 11 12 13 14 15 16
1000 2000 3000 4000 5000 6000 7000 8000

FIG. 10.—SPEED, POWER AND REVOLUTION CURVES

surface condensing engines with cylinders 28½, 46½ and 78 inches in diameter with a common stroke of 54 inches. The engines were designed to develop an indicated horsepower, collectively, of 7,500 at about 86 revolutions per minute, in order to give the ship a speed of 16½ knots. The main air pumps and the main feed and bilge pumps are driven off the main engines. The propellers are three-bladed with a diameter of 15 feet and a pitch as designed and held of 21 feet 7½ inches. The developed area of the three blades of each propeller is 77½ square feet and the projected area 59.6 square feet. The propellers are so constructed that the pitch is adjustable 12 inches either way. Steam is supplied by 10 single-ended marine boilers, 15 feet inside diameter and 11 feet 10 inches inside length, with a total heating surface of 22,116 square feet. They are constructed for a working pressure of 180 pounds per square inch under natural draft, and fired with oil fuel by means of the Dahl system of burners.

As the interior arrangements of this vessel are entirely new to the coasting trade, and as this large and finely appointed ship has been designed to meet the requirements of a rapidly growing business that bids fair to demand a type of coasting vessel that was not dreamed of twenty years ago, a few illustrations will serve to show far better than words the type of vessel that is coming within the reach of those who travel by sea on the Pacific Coast of the United States.

The first thing that interests the passenger who never misses a meal is the dining room. This room on the *Congress* is 75 feet long and 53 feet wide, and has 54 tables seating four persons each. The seats are arranged as a solid frame in polished mahogany, each surrounding a column encasing the steel deck pillars. The seats fold down and the seats and backs are upholstered in dark green leather. The floor in this room is of dreadnaught tiling. The tables at the sides are in alcoves which are formed by deep web frames. There are two 16-inch portholes in each alcove, making 42 in all. A window frame of prism glass covers the portholes, giving the appearance of large windows. These open for ventilation. Above the seats the room is finished in an ivory tint with parapan enamel, the roof being in flat white. Fig. 6 gives a very good idea of the attractiveness of this room.

The first class lounge has been designed to meet the requirements of the passenger who seeks an elegant and airy place to rest. This room is on the bridge deck and is 48 feet by 40 feet in size. There are three large bay windows on each side, between which the electrical heaters are worked into fireplaces. Fig. 8 gives a good idea of the style of this room, the green carpet and green upholstery making a fine contrast with the mahogany finish.

The first class smoking room (Fig. 9) is on the boat deck forward, and the second class smoking room on the bridge deck aft. Both of these rooms are large, airy and comfortable, and both are finished in quartered oak.

The captain's quarters, immediately forward of the first class smoking room, consist of a very handsome apartment

TABLE I.—DATA FROM STANDARDIZATION TRIALS OF S. S. CONGRESS OVER DELAWARE BREAKWATER COURSE, JULY 20, 1913.

| No. of Run. | Direction. | Total Revs. | Mean Total Revs. | Average R. P. M. | Mean R. P. M. | Elapsed Time on Course in min. | Mean Speed. | I. H. P. | Mean I. H. P. | Pressure by Gage. Main Steam. | I. P. Rec. | L. P. Rec. | Vac. in Inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N | 305<br>303 | 304 | 52.3<br>52. | 52.6 | 5.83 | 9.76 | 590<br>607 | 1226 | 165<br>169 | 3<br>0 | 11 ins<br>11½ " | 27.8<br>27.6 |
| 2 | S | 371<br>371 | 371 | 53<br>53 | | 7.00 | | 616<br>639 | | 168<br>170 | 3<br>0 | 11 "<br>11½ " | 27.6<br>27.6 |
| 3 | N | 291<br>289 | 290 | 68.16<br>67.7 | 68.2 | 4.27 | 12.95 | 1749<br>1369 | 3210 | 169<br>170 | 17<br>13 | 0<br>0 | 27.7<br>27.75 |
| 4 | S | 374<br>373 | 373½ | 68.6<br>68.4 | | 5.458 | | 1716<br>1587 | | 168<br>169 | 16<br>13 | 0<br>0 | 27.8<br>27.7 |
| 5 | N | 304<br>304 | 304 | 78.61<br>78.61 | 78.9 | 3.867 | 14.5 | 2231<br>2123 | 4342 | 168<br>169 | 30<br>25 | | 27.6<br>27.75 |
| 6 | S | 381<br>379 | 379 | 79.68<br>78.8 | | 4.783 | | 2216<br>2115 | | 167<br>169 | 29<br>26 | | 27.5<br>27.75 |
| 7 | N | 326<br>319 | 322½ | 86.4<br>84.52 | 85.5 | 3.773 | 15.25 | 2913<br>2648 | 5627 | 167<br>169 | 42<br>35 | 2 lbs<br>1½ " | 27.3<br>27.75 |
| 8 | S | 380<br>371 | 375½ | 86.61<br>84.58 | | 4.387 | | 2967<br>2727 | | 167<br>168 | 41<br>36 | 2 "<br>1½ " | 27.1<br>27.75 |
| 9 | N | 328<br>326 | 327 | 91.92<br>91.36 | 91.3 | 3.567 | 16.30 | 3586<br>3553 | 6978 | 159<br>162 | 54<br>34 | 6½ "<br>6½ " | 27.6<br>27.1 |
| 10 | S | 375<br>370 | 372½ | 91.6<br>90.4 | | 4.092 | | 3402<br>3415 | | 153<br>156 | 50<br>50 | 6 "<br>6 " | 27.6<br>27.0 |

en suite in mahogany. These rooms are directly under the bridge and are of unusual size, attractively arranged.

The second class passengers have been provided with comforts unknown to that class of travel on the Pacific Coast. The second class lounge, at the after end of the bridge deck, shown in Fig. 2, is one of the most attractive public rooms on the ship. The second class dining saloon on the upper deck is also a very handsome room. These rooms are in quartered oak.

There are some very handsome staterooms on the *Congress*, a very good example of which is shown in Fig. 3. This room is one of a suite finished in bird's eye maple with blue draperies and upholstery. The deck lounges at the head of the stairs on the boat deck, which are finished in quartered oak with upholstery in red plush, are also a feature of this ship.

A very attractive feature of the *Congress*, especially on that part of her run south of Point Conception, where the water is smooth and the evenings balmy, is the ball room on the after end of the boat deck. The roof of this room is supported by girders, so that the entire floor space is available for dancing. Another feature of interest regarding the boat deck is the arrangement of the life boats and life rafts. There are 14 large lifeboats to carry 42 persons each and 14 life rafts with a capacity of 19 persons each stowed under them. All these are handled by Norton patent sheathed screw davits, and they are so arranged that much of the deck space is left free for the use of the passengers.

Whatever the success of this vessel may be, she illustrates the efforts being made to produce ships that are not only seaworthy and safe, but are of such a character as to discount all the discomforts of coastwise travel on the ocean.

## Bunkering H. M. S. Melpomene

The Havana Coal Company, Havana, Cuba, has made itself independent of the crowd of unreliable laborers formerly required in coaling vessels by adopting coaling barges equipped by the Link-Belt Company, of Philadelphia, with machinery for handling run-of-mine coal at the rate of 125 to 150 tons per hour for each barge. The arrangement in each case includes two strong apron conveyors running the entire length of the barge under the storage space, receiving coal through Link-Belt under-cut gates, and delivering it to a Link-Belt gravity discharge elevator, which runs to a sufficient height to secure a proper angle of flow through a swivel spout leading to the different bunkers of the ship as desired. The barges can receive their supply of coal at the docks in relatively shallow water, and deliver to deep-draft vessels out in the harbor, in the manner shown by the accompanying view of two of the Havana Coal Company's barges bunkering H.M.S. *Melpomene*.

TWO OF THE HAVANA COAL COMPANY'S BARGES EQUIPPED WITH LINK-BELT COALING APPARATUS BUNKERING H. M. S. MELPOMENE

The use of these outfits greatly decreases the expense of handling the coal, besides saving much time for the vessel, and their rugged construction and great efficiency are consequently attracting the favorable attention of coaling companies in various parts of the world, as evidenced by a recent shipment to the Rapid Coaling Syndicate, Ltd., Liverpool.

United States Destroyer Trials.—The average speed of the destroyer *Cummings*, built by Bath Iron Works, during her 4-hour endurance test off Rockland, Me., Aug. 27, was 30.52 knots. The destroyer *Parker*, built by the Cramp Ship & Engine Company, Philadelphia, on an unofficial trial over the Delaware Breakwater course, attained a speed of 29.6 knots.

# The Influence of Air Pumps on the Military Efficiency of Turbine-Driven Warships *

BY D. B. MORISON

This paper assumes a recognition of: (*a*) Military value of speed in a warship; (*b*) tactical value of reliability in production and maintenance of maximum speed, according to the requirements and expectations of the commanding officer.

In the equipment of a steam turbine installation there is no auxiliary engine which has a more important bearing on a warship's speed than the air pumps of the condensing plant. This importance arises because of the influence of vacuum on propelling power, and because it is air pump efficiency which,

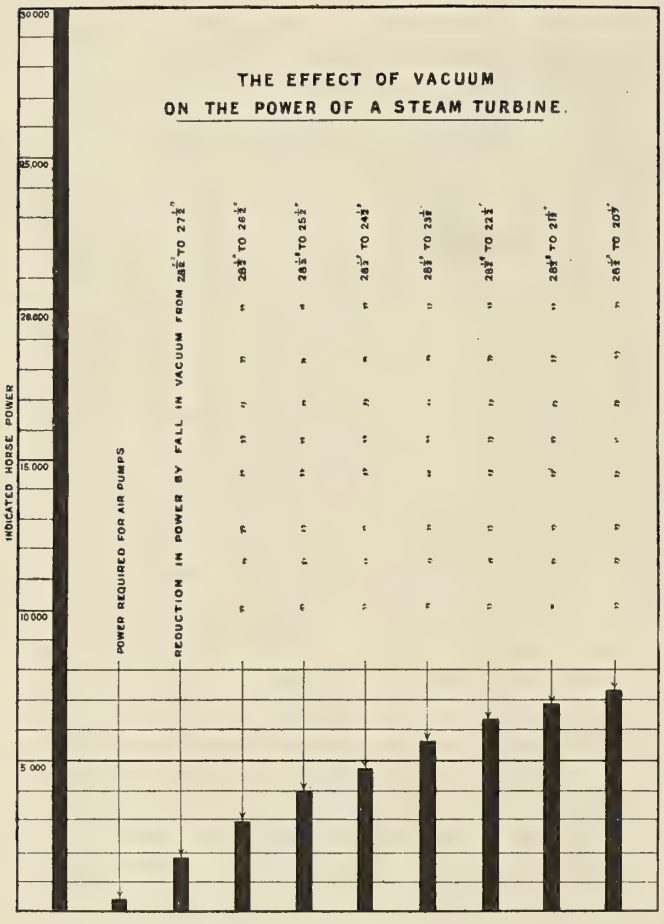



FIG. 1

under given conditions, enables the condenser to produce the highest vacuum obtainable, and air pump sufficiency which enables such vacuum to be maintained when air beyond the normal quantity is present in the condensing system.

The degree of vacuum at which any turbine will develop its maximum power with maximum economy depends on the design of the turbine, and the detail design is determined by the compromise best suited to any given range of conditions, such as temperature of sea water, weight, space occupied, etc. According to latest cruiser practice, a vacuum of 28½ inches is required at full power in sea water at 55 degrees, and, provided that the turbine is bladed to make adequate response in power to such a vacuum, then Fig. 1 shows the loss in power which results from a fall of vacuum.

The source of power is, of course, the boilers, and therefore the maximum power obtainable depends primarily on the quantity of steam which can at any time be generated. But if under conditions of maximum and constant generation of steam in the boilers the vacuum falls from 28½ inches to 27½ inches, then the immediate loss in power is about 6 percent, or say 1,800 indicated horsepower in a cruiser of 30,000 indicated horsepower. In warship practice the exhaust steam from all the auxiliary engines is discharged into a receiver, and at full power is maintained at 25 pounds pressure. Apart from its employment in an evaporator the heat in this steam can be utilized to the best thermal advantage in raising the temperature of the feed water, and the most advantageous use that can be made of any surplus is for power production in the low-pressure section of the main turbine. If, under full power conditions and at 28½ inches vacuum, sufficient exhaust steam is available to raise the temperature of the feed to a predetermined limit, then at 27½ inches vacuum there would be a surplus of such steam, because of the increased initial temperature of the condensate. If this surplus were utilized for power production in the low-pressure section of the main turbine the increase in power would be slightly under 1 percent. Assuming, as is generally the case, that for reasons of weight and space occupied there is no feed-heating apparatus in a warship, then this increase in condensate temperature due to the lower vacuum would probably raise the steam generating efficiency of the boiler by about 1½ percent. Therefore, even after adjusting the diagram, Fig. 1, to the most favorable conditions of working, the loss due to a fall of 1 inch of vacuum is still about 1,400 indicated horsepower for the same weight of fuel consumed, and about 20 tons of coal per day are wasted.

The effect on the power of a turbine of steam pressure at the entry, and of vacuum at the discharge, is of interest. If it were desired to lower the steam pressure at the entry to the turbine to a point which would correspond to the loss in power consequent on a fall in vacuum from 28½ inches to 26½ inches, it would be necessary to reduce such pressure from, say, 200 pounds to about 110 pounds, other things being equal. That is to say, the pressure of steam entering the turbine would have to be reduced about 90 pounds in order to cause a loss in power similar to that which results from an increase in condenser pressure of only 1 pound.

The alternative effect to loss of power by a fall in vacuum is an increase in the quantity of steam necessary for the development of a given power, thereby reducing the radius of action obtainable from a given weight of fuel. The broad question of vacuum on a turbine-driven warship is therefore one of great military importance.

The highest vacuum that any given condenser could maintain under given conditions would be realized if no air entered the condenser.* This airless state is impossible, as some air is always circulating through the system from the boiler to the boiler, and may at any time be augmented by insidious leakage through joints in the vacuum system.

The primary function of an air pump is to enble the condenser to maintain within itself the nearest approach possible to the condition that would prevail were the steam airless. In practice, therefore, the *minimum* capacity of an air pump is determined by the quantity of air in suspension and solution in the feed water as it enters the boiler, without provision for insidious leakage from joints, glands, rivets, bolts, cocks, valves and the like which are included within the vacuum system.

The effect of insidious air leakage on the action of an air pump may be realized to some extent by the fact that 1 cubic inch of air at atmospheric pressure, subject to its relative temperature when augmented by water vapor, will become in a condenser at 28½ inches vacuum about 50 cubic inches. From

*Abstract of a paper read before the Institution of Naval Architects, London, March 12, 1913.

* The writer has dealt at length with surface condenser efficiency in an article appearing in the current issue of the *Journal of American Naval Engineers.*

this it is obvious that if the designed capacity of an air pump provides for no air leakage beyond what enters the system with the steam, then any such leakage, no matter how small it may be, will cause a fall in vacuum, a loss in propelling power, and a reduction in the speed of the ship. An air pump of this basis capacity may be said to have no air margin.

In land practice the electrical engineer is never without a substantial air margin on a turbine condensing plant. He has learned from experience that, at times, no matter how carefully the plant may be manufactured and the joints made, air will leak into the vacuum system, and that it is generally a most difficult and tedious process to locate the leakage. If the pump has no air margin the vacuum falls, the cost of producing electrical energy rises and profits suffer. He knows

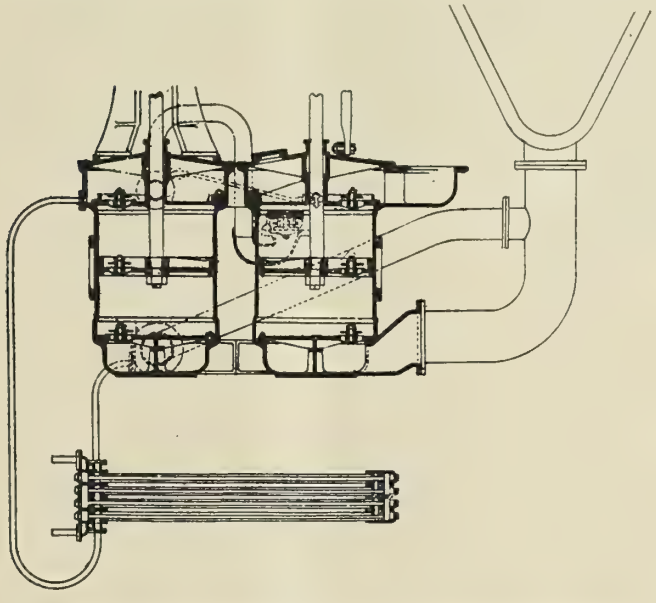


FIG. 2.—RECIPROCATING AIR PUMPS, WET AND DRY INTERDEPENDENT SYSTEM

that the only way of adequately providing against this loss is by the adoption of such proportions as will deal with air leakage contingencies.

A warship presents a somewhat different problem by reason of limitations of weight, space and economy of steam under varying load and conditions of service, the extremes being maximum power at full speed and harbor duty at rest. The only margins allowable in this problem of obtaining the greatest power from a given weight of machinery and a given quantity of fuel are those which are essential to efficiency and safety under the most severe conditions in actual warfare.

Compare, for instance, the conditions of the feed pumps with those of the air pumps on a warship and the relative consequences in the event of the breakdown, in action, of a feed pump and an air pump. If a feed pump breaks down entirely there is merely a temporary inconvenience, as ample provision is always made in the boiler feed system for such a contingency. In a military sense the consequences would be *nil*, as the speed of the ship would be unaffected. Not so with an air pump. Break down an air pump and the warship at once becomes a slower and less reliable unit, unable to respond to the speed expectations of her commanding officer, and in addition there are the mechanical risks due to the extra water load to be sustained by the other air pumps which may be available for parallel working.

Fortunately, the total mechanical breakdown of an air pump is a rare occurrence, but the danger, of course, is always present. Therefore, in view of the inevitable loss in propelling power from an accident, which would in many cases affect the vacuum system as a whole, and of the consequences which might result therefrom, a reasonably adequate factor of safety becomes imperative. Next in importance to a breakdown of the mechanism of an air pump comes its breakdown in adequacy of air-withdrawing capacity, should there be such a disturbance of the normal air-tightness as would cause the quantity of air to exceed that with which the air pump can deal without a drop in vacuum. It should be noted that although such a disturbance would generally affect only one section of the condensing plant, it would nevertheless have a detrimental effect on the speed of the ship.

The vacuum system comprises every part under the influence of vacuum, and what is accepted as an air-tight system is one in which every joint, gland, valve, cock, or other con-

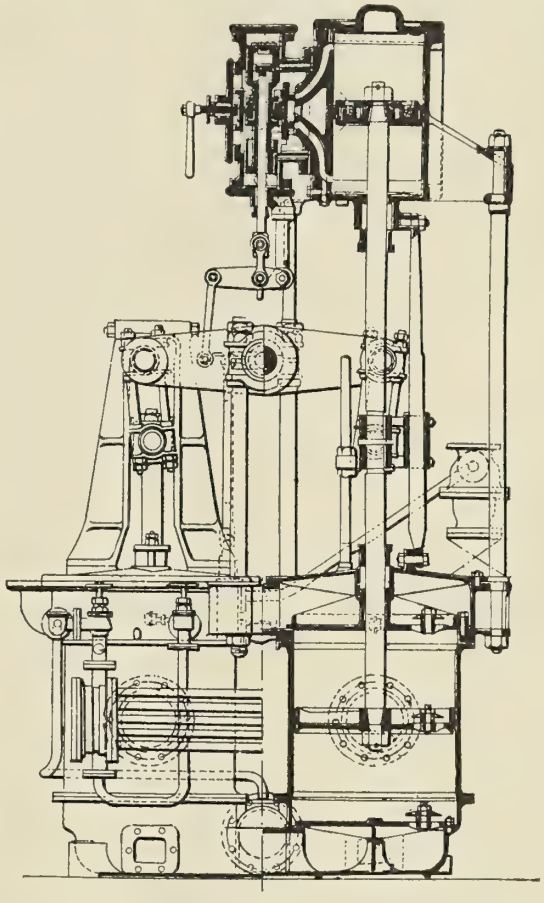


FIG. 3.—INDEPENDENT WET AND DRY AIR PUMPS

nection is capable of resisting the admission of any air. This condition is arrived at in practice by a process of tuning up, which means exercising the greatest possible care in workmanship, going over all the joints and connections with paint or varnish and carefully examining every fitting, including even the cocks and union nipples of the vacuum gages. A difficult and tedious task, as Admiralty contractors know full well. If the air pump capacity of the ship is determined on the basis of ideal tightness, then unless such ideal tightness is achieved there can be no improvement except by driving the air pump in excess of the regulation limit, an expedient which is admittedly unsatisfactory. The all-important question is, will ideal air-tightness be maintained under the severe conditions of war, and if not maintained can the possible leakage at once be located and stopped? My reply, based on long experience with high vacuum plants of the highest class, would be in the negative, as I have found it futile to expect continued maintenance of ideal tightness. Insidious leakage always commences, and the invariable opinion of engineers in charge of high-vacuum plants is that air leakage is sooner or later in-

evitable and generally very difficult indeed to locate. If such is the position on land, what may be expected under the severity of the conditions of vibration, shock and stress certain to be associated with a naval action. Under peace conditions the position never becomes serious, as the standard of maintained excellence on a warship is extremely high, as is also the standard of the *personnel.* It is in war time that this question will become acute. The endurance of every man has its limit, and what the physical condition of the engineering *personnel*

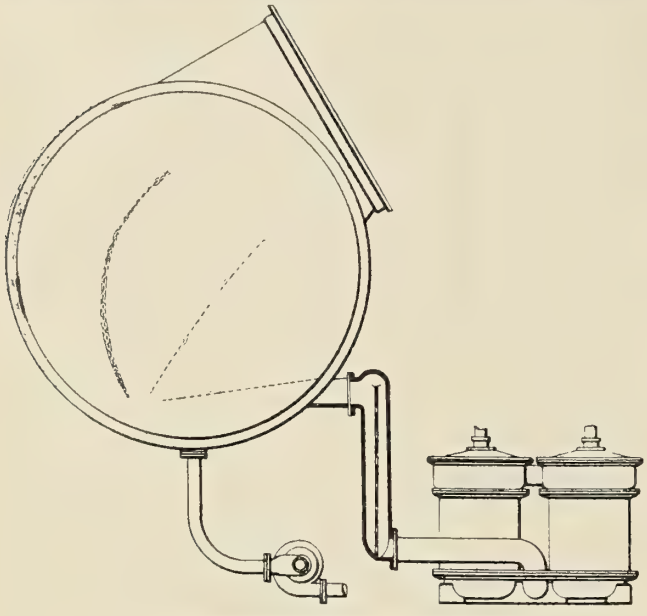


FIG. 4.—SEMI-ROTARY SYSTEM OF AIR PUMPS

after a few days of war in deadly earnest will be is a question in reply to which we all pray may be long deferred.

I would here refer those to whom my fears may appear exaggerated or groundless to Fig. 1. In the next naval war in which modern ships are engaged it will be reliability of performance which will tell. It is not enough that a ship *has traveled* at her designed speed; it is rather that such precautions are taken that she *will travel* at that speed when required, notwithstanding trifling departures from the normal.

Having set forth the essential contention of this paper, it will be useful to refer in a general way to types of air pumps which embody distinctive features, in order to ascertain to what extent an air margin can be provided consistently with the exacting requirements of the problem. The air pumps in the British navy are of the reciprocating type, although a rotary one, on the kinetic principle, was recently fitted on a torpedo boat. In 1908 the writer, in a paper on "The Influence of Air on Vacuum in Surface Condensers," dealt at length with the advantages obtainable by what is known as a "cooled dry air pump." In 1909 the Admiralty adopted the air pump shown in Fig. 2. It consists of twin wet and dry reciprocating pumps of the ordinary foot-and-bucket valve type, driven by one steam cylinder and levers in the ordinary way. The wet barrel withdraws the water and the so-called dry barrel the air, the feature of interest being that the air delivered by the dry barrel into its discharge chamber passes through a loaded valve into the wet barrel between the bucket and the delivery valves, and is discharged thence with the condensate in the ordinary manner. This valve is loaded to 4 pounds per square inch, and therefore the load on the bucket of the dry barrel is lessened, thus favorably influencing the power required. The air-withdrawing capacity of the dry barrel is practically unaffected by the reduction in discharge pressure, and in this system the pumps are not independent.

Fig. 3 represents another system of wet and dry reciprocating air pumps. The wet and dry barrels, the water-cooling arrangement, and, indeed, all details, are broadly similar in Figs. 2 and 3, except that in Fig. 3 the dry pump delivers direct to the atmosphere. The wet and dry barrels are, therefore, independent in every way, so that in the event of the breakdown or derangement of either pump, the other can withdraw both air and water from the condenser. The vapor withdrawn from the condenser with the air and discharged by the dry pump as water may be taken from the discharge chamber by a small plunger pump driven from the lever and delivered to the feed tank or elsewhere as desired.

In each of these systems (Figs. 2 and 3) the whole of the water is withdrawn from the condenser by the wet barrel, and as the amount at full power is considerable, and in a seaway erratic in supply, it follows that the speed at which the pumps can be driven with safety is governed by the water considerations of the wet pump. This is termed the Admiralty limit speed, and must not be exceeded on a warship full-power trial.

Fig. 4 shows a semi-rotary system whereby the water is withdrawn by a small rotary pump, working in combination with reciprocating pumps, thus rendering both barrels of the reciprocating pumps available for withdrawing air. When in harbor, or when cruising at low speeds, the rotary pump may be stopped and the water and air withdrawn on the wet and

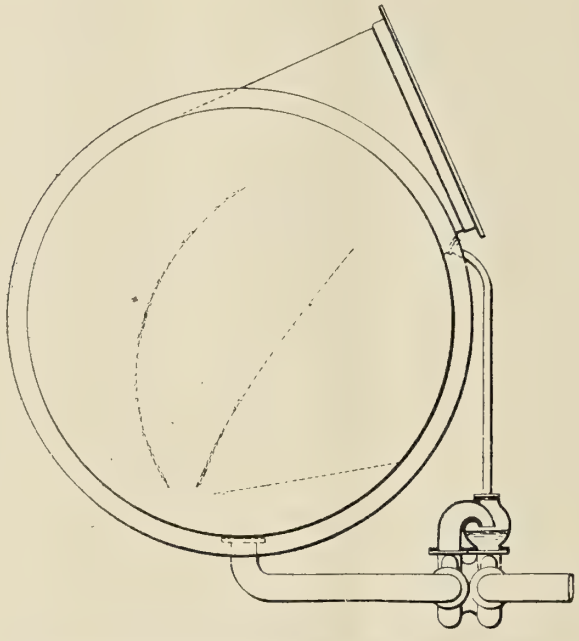


FIG. 5.—CONDENSATE PUMP, HEAD AND PRESSURE SYSTEM

dry system as in Fig. 3. Fig. 4 also shows a safety device placed between the rotary and reciprocating pumps, so that in the event of a sudden stoppage of the rotary pump the water would be automatically and gradually delivered to the reciprocating pump, thereby preventing shocks. This safety device is of value in combination with any reciprocating water-extracting pump, particularly in a heavy seaway, when sudden gluts of water are inevitable.

The semi-rotary system (Fig. 4) involves the use of a centrifugal water-extracting pump driven by either a small steam turbine or an electric motor. For a condenser dealing with steam from a 10,000-horsepower main turbine, the horsepower would, even with a considerable margin, not exceed 10. What are the advantages? For example, take the air-withdrawing capacity of a pair of wet and dry pumps (Fig. 2) at the regulation number of strokes per minute. The air-withdrawing capacity of a set of pumps on the semi-rotary system, with the same diameter and stroke, is increased by about 50 percent. Moreover, in the semi-rotary system, as

both barrels draw air only, and each barrel is supplied with a constant and uniform quantity of sealing water per stroke, the regulation number of strokes per minute can be increased by at least 50 percent without affecting the margin of safety and durability. Therefore, by the addition of a small centrifugal pump, the ultimate air-withdrawing capacity is more than doubled. Another feature of advantage is that even under conditions of extreme severity—for instance, at full power in a heavy seaway—the factor of safety on the reciprocating air-pump mechanism is constant. There are neither shocks nor jars due to gluts of water in irregular supply, the working of the pumps is smooth and regular, and is totally unaffected by variable quantity of condensate. In harbor, or when it is not necessary to work the rotary pump, the operation of a change valve enables the reciprocating pumps to be converted from parallel working as dry air pumps into the wet and dry

FIG. 6.—ROTARY AIR EXTRACTOR, WATER TURBINE SYSTEM

system, whereby the air-pump duty under light loads is maintained with a minimum consumption of steam.

Fig. 5 shows a type of "head and pressure" condensate pump, which is very reliable in practice. There are two impellers—the first discharges into an air-separating chamber at or about the normally maintained suction level of the second pump. From this chamber extends a vertical standpipe, which is connected at the top to the condenser. No lodgement of air is possible in this pump. It will work under a suction head of as little as from 6 inches to 9 inches, and is designed to meet marine requirements.

The steam economy of such a small turbine as 10 brake-horsepower is low, so that an alternative drive for this pump would be by an enclosed waterproof electric motor, thereby favorably influencing the steam consumption. There can be no question as to the great increase in air capacity obtainable by this semi-rotary system, and notwithstanding all that Fig. 1 may mean to a warship, it might be legitimate to reduce the size of the reciprocating pumps by an amount which would compensate in part for the weight of the small centrifugals. That, however, is a question which must be left to the decision of naval experts.

Another feature of this semi-rotary system is that it can be fitted to existing ships with a minimum of disturbance and cost. Whenever the system is tried in this manner the advantages at full power, and especially in a seaway, will be found to be very considerable when compared with the pure reciprocating system, the inherent defect of which is the extremely low volumetric efficiency of the wet barrel as a withdrawer of both air and water.

The designer of warship machinery when considering any new development naturally hesitates before recommending a radical change, as there are so many requirements which have to be met, but the semi-rotary system of air pumps involves not so much a change as an addition, viz.: a very small motor-driven centrifugal added to known and existing air-withdrawing apparatus. By means of this small addition the available air capacity at the full speed of the ship is more than doubled; the factor of safety of the existing mechanism is considerably increased, and the admitted steam economy for harbor duty is retained. Moreover, the semi-rotary system is a step forward towards the realization of the complete rotary system, in that it enables experience to be gained on an essential part of the complete rotary system, viz.: the rotary water extractor.

Suppose, for instance, on a 30,000-horsepower cruiser there were four such centrifugals weighing collectively with pipes 4 tons; again, suppose a fall in vacuum by air of only 1 inch. Such a fall would involve an effective loss of about 20 tons of coal per 24 hours, or five times the weight of the apparatus.

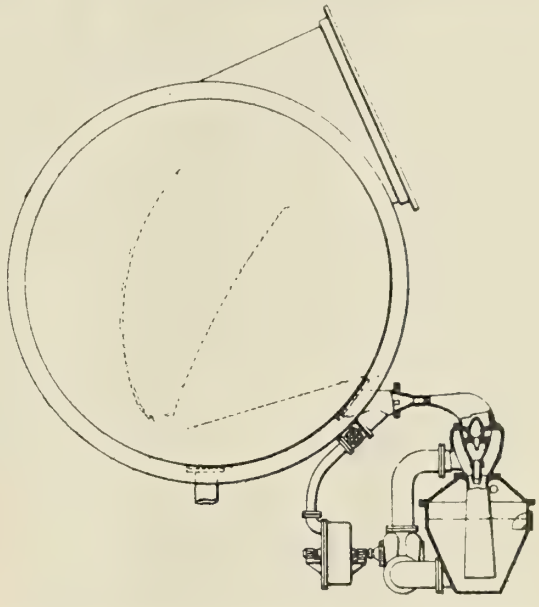


FIG. 7.—AIR WITHDRAWN BY COMBINED STEAM AND CONDENSATE JETS

In other words, the entire weight of the apparatus would be represented by the coal wasted in 24 hours by a fall of about one-quarter of an inch in vacuum, caused by insufficient air-pump capacity.

Sir Charles Parsons' well-known system of combining a steam jet air-withdrawing device with a reciprocating air pump, the steam from the jet being condensed in an intermediate surface condenser, has frequently been described in the *Transactions* of this institution, and is well known to be a highly efficient apparatus.

Fig. 6 shows in diagrammatic outline a rotary air pump which withdraws the air by water films discharged from a turbine wheel. If sea water is used for air-expelling purposes the water resulting from the condensation of the vapor necessarily withdrawn along with the air is lost. Another feature is that the theoretical limit of vacuum is not the barometric pressure but the vacuum corresponding to the temperature of the sea water used for air-expelling purposes.

Fig. 7 shows a complete rotary system whereby the air is withdrawn and discharged by means of the kinetic energy of combined steam and water jets. It is in extensive use on land, and has been sanctioned and is under construction for one of the light armored cruisers at present building. An outstanding feature of the apparatus is that the air-expelling medium is the condensate, so that the entire heat of the steam jet, together with the vapor withdrawn from the condenser, is absorbed and conserved. There is no loss of heat and no loss of water; in fact, neglecting radiation, the thermal efficiency of the system is unity, and, what is very important,

the basis limit of rarefaction by the apparatus is the barometric pressure. The condensate is withdrawn by a centrifugal pump, and passes into a circulating receiver, from which it flows to the feed tank. The air is withdrawn from the condenser by a steam jet, and the aerated steam is discharged into a chamber in which condensate is sprayed by multiple jets, thereby presenting a large water surface by which the steam from the jet is condensed, and on which the air is, as it were, automatically deposited. The resultant highly aerated water is delivered to an annular water jet in the base of the chamber by which it is discharged. An ordinary centrifugal pump draws water from the circulating receiver and delivers it to the spraying jets and to the annular air-expelling jets. The

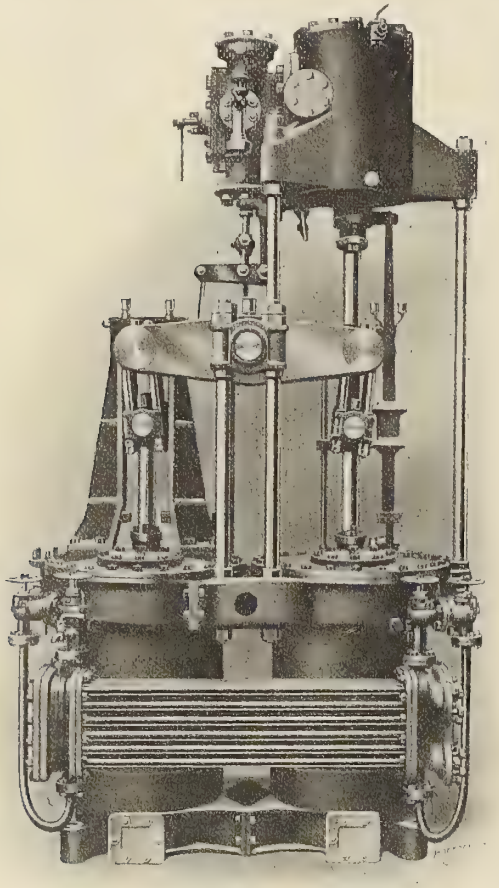


FIG. 8

steam jet is supplied from the closed exhaust system, therefore the apparatus becomes in effect an exhaust steam feed-water heater, but before heating the water the exhaust steam is usefully employed in withdrawing the air from the condenser. The centrifugal pump is driven by a small turbine, there being no other moving mechanism whatever. In a 30,000-horsepower cruiser there would be, say, four sets of apparatus, the water horsepower of each set being about 30.

It is well known that the steam consumption per horsepower of small steam turbines is high compared with that of a reciprocating engine, such as is used for driving the wet and dry reciprocating pumps, but when exhausting into the usual closed exhaust system about 70 percent of the work of which the steam as delivered to the small turbines was originally capable is still available for generating power on the low-pressure section of the main propelling turbine. In this connection it may be mentioned that the exhaust from this small turbine is dry, so is in an eminently suitable condition for admission to the main turbine, whereas the exhaust from the reciprocating engine is super-saturated. The apparatus is fascinating, because it is completely rotary, and, being so, it is uniform with the main turbines; it is also very simple. As a remover of highly rarefied air, such, for example, as is associated with 28½-inch vacuum, it is ideal. The air capacity of the four sets referred to is, at 28½-inch vacuum, more than double that of the ordinary installation of wet and dry reciprocating pumps usually fitted on a 30,000-horsepower cruiser. The system is essentially one for vacua over 26 inches, and the higher the vacuum the more strikingly efficient it is, provided in all cases the condenser is of suitable design.

In order to obtain reliable data, a very exhaustive series of tests has been made on the reciprocating air pumps shown in Fig. 8. The design meets Admiralty requirements, and is in accordance with recognized first-class practice. The method

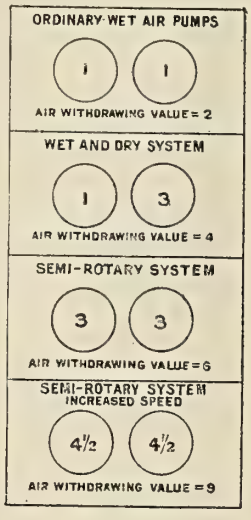



FIG. 9

of testing adopted was the usual one of withdrawing from a receiver into which air is admitted in known quantity, and through which water passes in known quantity and at known temperature. The results obtained from such tests are, of course, not identical in a quantitative sense with what might be expected from a condenser in actual operation; they, nevertheless, permit of exact comparisons being made.

The pumps were arranged to work on the following systems:

(*a*) Water withdrawn by wet barrel and air by dry barrel, both discharging to atmosphere.

(*b*) Water barrel discharging to atmosphere and air barrel against pressures below atmospheric.

(*c*) Both barrels withdrawing air in parallel as in semi-rotary system.

The temperature of the water passing through the wet barrel ranged from 70 to 120 degrees, and that passing through the dry barrel from 50 to 90 degrees, thereby covering all the conditions met with in practice.

Referring again to the basis example, viz., 28½ inches condenser vacuum with 55 degrees sea water, and assuming the condensate to be 80 degrees, the conclusions are as follows:

The air-withdrawing capacity of the dry barrel is about three times greater than the wet barrel.

There is no measurable difference in the quantity of air withdrawn by reducing the discharge pressure from atmospheric to, say, 4 pounds absolute.

If both barrels are worked dry in parallel, as in the semi-rotary system, the air capacity per minute is one-half greater than on the wet and dry system at the same number of strokes per minute.

With both barrels working in parallel as air barrels at a number of strokes per minute 50 percent greater than the regulation strokes permissible on the wet and dry system, the smoothness of working is at least equal to that obtained by the wet and dry system at the regulation strokes, and at this

increased speed the air-withdrawing capacity is more than doubled. (See Fig. 9.)

Fig. 10 is a section of the apparatus on which experiments were made on air withdrawal by the kinetic energy of steam and water jets. The temperature of the condensate was again assumed to be 80 degrees, and 5 degrees were added for heating by the steam jet, so that the temperature of the water in the circulating tank was maintained throughout the tests at 85 degrees. The water-horsepower of the centrifugal pump supplying the jets was 33. With no air separately admitted, and with water at 85 degrees passing through the jets, a vacuum of 29.8 was maintained with barometer at 30 inches. A vacuum of 28½ inches was maintained under the above conditions with an air admission of 50 cubic feet per minute.

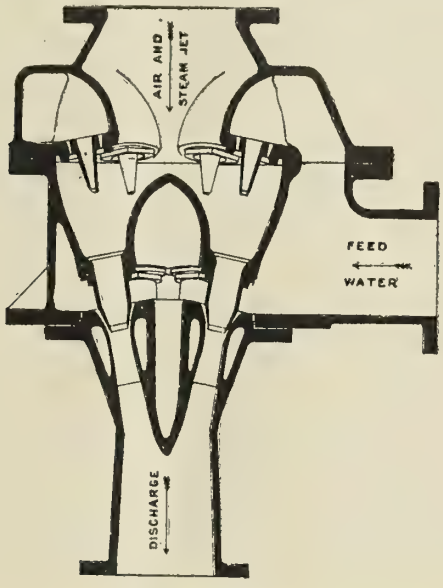



FIG. 10

A vacuum of 28 inches was maintained under the above conditions with an air admission of 65 cubic feet per minute. This result is beyond the requirements of ordinary practice, and was made to illustrate the possibilities of the system.

Having reviewed the broad question of air margin for air pumps the proposition I venture to submit for consideration is as follows:

There is an ascertainable and minimum quantity of air passing through a turbine system to the boiler as air in suspension and solution in the feed water, and from the boiler into the condenser as air in the steam, this quantity being based on the assumption that the joints, etc., in the vacuum system are absolutely air-tight.

If at full power the capacity of the air pumps at the specified vacuum is based on this quantity of air, the pumps may be said to have no air margin. In view of the influence of vacuum on power and of the influence of microscopic air leakages on vacuum, is it or is it not desirable to provide warship air pumps with an air margin at full power, and, if so, what should the air margin be relatively to the normal quantity of air passing through an air-tight system per unit weight of feed water?

In conclusion, I may say that my endeavor has been to set forth within the limits of a paper the influence of an air pump on the military efficiency of a turbine-driven warship. It is a subject which should appeal alike to the naval constructor, the naval engineer, and the commanding officer. Its consideration brings into prominence the far-sighted policy of the new scheme of naval training whereby all the officers in His Majesty's navy will have passed through an engineering course and be able in the future to review professionally the many subtle problems involved in that wonderful aggregation of mechanism—a modern warship.

## Ocean-Going Twin Screw Salvage Tug for the Brazilian Government

The twin screw tug *Carioca* is an ocean-going vessel built by Messrs. Napier & Miller, Ltd., Old Kilmarnock, near Glasgow, for the Federal Government of Brazil under the inspection of the Brazilian Naval Commission.

The principal dimensions are: Length between perpendiculars, 120 feet; beam, molded, 20 feet; depth, molded, 9 feet 6 inches. The propelling machinery, supplied by Messrs. Miller & Macfie, Ltd., of Kinning Park, Glasgow, consists of two sets of three-crank triple expansion engines with cylinders 8 inches, 12 inches and 18 inches diameter, and 12-inch stroke, with one large boiler designed to give a speed of 10½ knots.

FIG. 1.—TUG CARIOCA LEAVING THE CLYDE

The cylinders are all cast separate, the high-pressure cylinders being provided with liners of good wearing cast iron.

The bed plate is of cast iron of "H" section throughout, a design which for small engines gives a combination of strength and lightness as well as simplicity. The cylinders on each engine are supported by six cast iron columns, also of "H" section, the front columns carrying both the ahead and the astern guides, in which case the propellers rotate outwards. The shafting is of mild steel throughout, the crankshaft being of the built-up type in one piece and having all dimensions in excess of Lloyd's requirements.

The tail shafts are so designed that they can be drawn outwards, and are lined with gun metal and suitably supported outboard by means of "A" brackets.

The propellers are three bladed and of solid cast iron. Both engines exhaust into one condenser. The condensing plant is of Messrs. Miller & Macfie's special design. The air, circulating and bilge pumps are worked by an independent reciprocating engine, and are situated at the forward end of the engine room, the piping to the condenser being led underneath the engine room floors. This arrangement of condensing plant has proved to be not only highly satisfactory, but also very convenient, as the exhaust of all the engine room and deck auxiliaries is led into the condenser. Provision is also made for the auxiliaries to exhaust into the atmosphere.

The air pump is of Edwards type, being 9½ inches in diameter by 6 inches stroke, and the circulating pump is of the centrifugal type, having a 4-inch discharge and an 18-inch impeller.

The engine has a 6-inch diameter cylinder by 6-inch stroke, and takes steam direct from the boiler. A Pickering type

of governor is fitted to the pumping engine stop valve, and is driven off the end of the crank shaft by means of a belt.

There is a feed pump on both port and starboard engines, worked by levers off the crossheads of the high-pressure engines. Both pumps draw from hot well on the pumping engine, and they are so arranged that either or both pumps can be shut off, in which case the donkey pump, which is also connected to the hot well, can be used for feeding the boiler.

The engine room auxiliaries consist of the pumping engine and a donkey pump, as already mentioned, and also a dynamo. The donkey pump can be used for circulating the condenser, and for various other purposes. The dynamo generates power for lighting the entire ship, as well as for a powerful searchlight situated on the navigating bridge, and for the Marconi wireless telegraphy apparatus. Situated on the main deck underneath the navigating bridge is a powerful centrifugal type salvage pump having a 10-inch diameter suction, driven direct by means of a reciprocating engine. It gets steam direct from the boiler and exhausts to condenser or atmosphere.

The suction and discharge pipes are so arranged that the pump can suck from or discharge to either side of the ship. A steam-driven windlass is fitted on the main deck forward for operating the anchors, as well as for salvage purposes, also a powerful fire pump, a complete diver's outfit, a rocket apparatus and a Pintsch gas pressure tank for charging lighted buoys. Accommodation for the crew is below the upper deck forward, while the officers and engineers are berthed in a large teak house abaft the engine casing, and the captain's quarters and the saloon are in the teak house forward. The Marconi operator's room (with silent chamber) is on the bridge.

There are five watertight bulkheads, two of these forming fresh water tanks, and coal is carried in the cross bunker forward of the boiler room. All the decks are of teak, and the vessel has been classed at Lloyd's under special survey for Brazilian coastal service, and, in view of the fact that the *Carioca* will be regularly engaged in tropical waters, special attention has been paid to the ventilation of the accommodation.

The *Carioca* left the Clyde on June 4 for Rio.

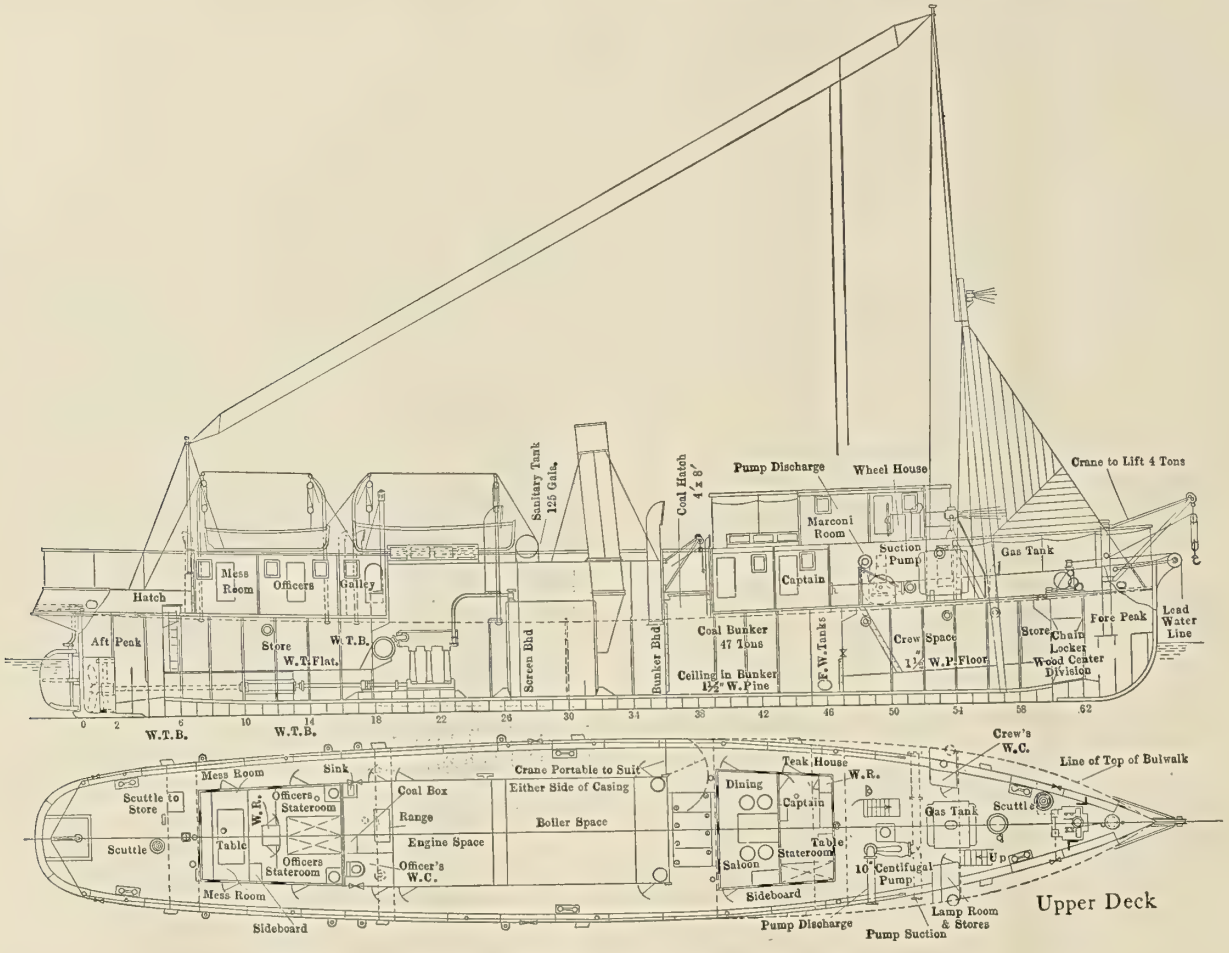



FIG. 2.—GENERAL ARRANGEMENT OF THE TWIN SCREW SALVAGE TUG CARIOCA

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation reports 143 sailing, steam and unrigged vessels of 21,151 gross tons built in the United States and officially numbered during the month of August. On the Atlantic coast nine steel steamships, aggregating 6,447 gross tons, were built, while on the Great Lakes two steel steamships, aggregating 2,753 gross tons, were built. The largest steamship reported for the month was the *Narragansett,* of 3,538 gross tons, built by the Harlan & Hollingsworth Corporation, Wilmington, Del.

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CONTRACTS FOR NEW DESTROYERS.—Contracts for the construction of six torpedo boat destroyers for the United States navy were awarded conditionally September 16 by the Secretary of the Navy Department. The destroyers are to be 310 feet long, 29 feet 10 inches beam, 9 feet 3 inches draft, 1,090 tons displacement and 29½ knots speed. All of the destroyers will use oil fuel and will be equipped with turbine machinery. The contracts were awarded as follows. Two vessels to the New York Shipbuilding Company, Camden, N. J., at $825,000 (£169,000) each; two to William Cramp & Sons Ship & Engine Building Company, Philadelphia, at $881,000 (£180,000) each; one to Fore River Shipbuilding Corporation, Quincy, Mass., at $861,000 (£176,500), and one to the Bath Iron Works, Bath, Me., at $884,000 (£181,300).

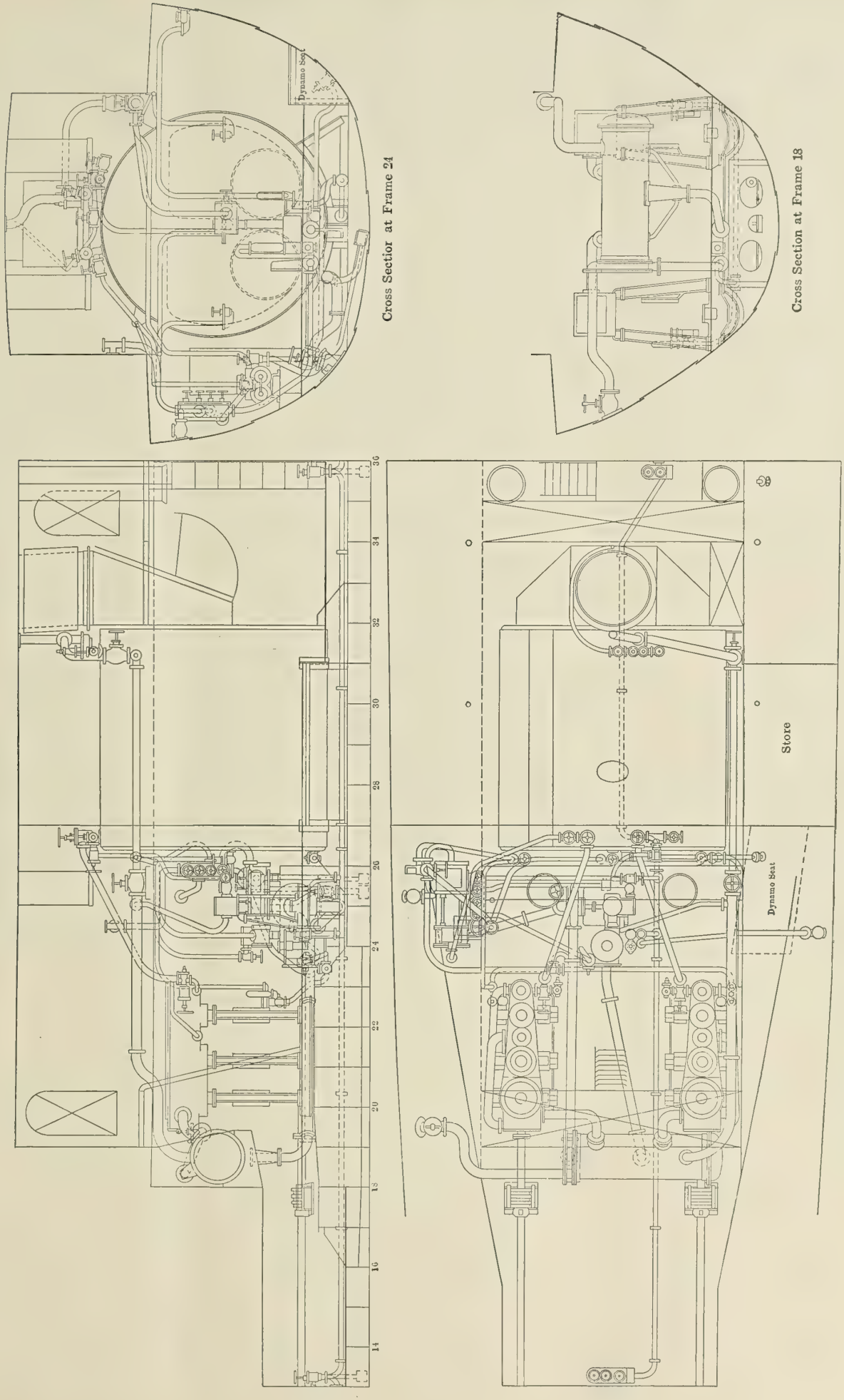



FIG. 3.—MACHINERY ARRANGEMENT OF THE TWIN SCREW OCEAN-GOING SALVAGE TUG CARIOCA, BUILT ON THE CLYDE FOR THE BRAZILIAN GOVERNMENT

# Steel Screw Ferry-Boat Edward T. Jeffery

BY J. B. SHIPLEY

The new steel double-ended screw ferry-boat *Edward T. Jeffery*, built for the Western Pacific Railroad Company at the Oakland yards of the Moore & Scott Engineering & Shipbuilding Works, was launched July 19, and went into commission about Aug. 15, taking the place of the stern-wheel steamer *Telephone*, which formerly connected the Western Pacific Railroad system at its terminal pier in Oakland and the ferry depot at the foot of Market street, San Francisco, Cal. The new ferry-boat is equipped for the conveyance of passengers, express, baggage and mail, and will later take care of the suburban traffic over this line. The general dimensions of the vessel are:

| | |
|---|---|
| Length, over all | 230 feet |
| Length, center to center of rudder posts | 218 feet |
| Beam, over guards | 62 feet 6 inches |
| Beam, molded | 42 feet |
| Depth to main deck | 19 feet 6 inches |
| Displacement | 1,150 tons |
| Total seating capacity | 1,400 persons |
| Draft | 11 feet 6 inches |

The hull is of steel, the heaviest plates being 22½ pounds and the lightest 15 pounds. The stern frames at the ends are of cast steel of the form shown on the inboard profile, Fig. 2, and are made in two pieces fitted together with a scarph.

The rudders are of the balanced double-plate type, the frames being steel forgings in one piece with 15-pound side plates. The interior of the rudder is filled solid with wood and resin. A steel collar, formed upon the upper end of the rudder, bearing upon a babbitted surface formed around the pintle in the upper part of the stern post, will carry the weight of rudder.

The keel plate, of trough section, is 24 inches wide of 29½ pounds. A floor stringer 12 inches wide and of 15-pound plate is fitted to the top of the keelson. The frames are of angle section, 8½ pounds, spaced 24-inch centers amidship and 21-inch centers at the ends of the ship. Web frames are fitted in the machinery space. The bulkheads, belt frames and the keelson are fitted for stiffening the structure, while the frames merely stiffen the shell.

FIG. 1.—LAUNCH OF THE FERRY-BOAT EDWARD T. JEFFERY AT THE MOORE & SCOTT IRON WORKS, OAKLAND, CAL.

The deck beams are 11.6-pound Z-bars, fitted to every frame and supported by channel stringers and stanchions. The greater part of the main deck is covered with steel plating and wood-laid, as is the case over the overhanging beams supporting the guards. The guard braces are 10-pound angles, fitted to alternate beams, palmed at the lower end where riveted to the shell.

Special attention has been given to the subdivision of the hull, there being ten complete watertight compartments, formed by transverse and longitudinal bulkheads, with a watertight door between the engine and boiler rooms. The engine seating is strongly constructed of exceptional length, and is worked into the structure of the vessel. The superstructure is of wood throughout, and fitted with skeleton steel bulkheads, two on either side of vessel, extending from the main deck to the saloon deck. The builders hope to eliminate

the vibration felt in the older vessels now plying San Francisco Bay in this more rigidly-constructed vessel, where every part is contributing to the general strength of the structure.

The enclosures around the engine room galley and restaurant up to the saloon deck and the engine-room skylight and boiler enclosure up to the upper deck are of 7½-pound plating. Steel doors are fitted to give access to the engine and boiler rooms and the restaurant off the main deck. There is a restaurant for ladies on the saloon deck and a grill on the lower deck for men.

On the main deck the interior is neatly and plainly finished in mahogany throughout, with T. & G. flooring covered with "Battleship Linoleum." The seats on the saloon deck are of mahogany with veneer backs, perforated. The crew's quarters are below the main deck aft of the engine room, and are light and roomy.

There is a combined steam and hand-steering gear. The steam gear has a hand wheel and control stand in each pilot house, with a 7-inch by 7-inch diameter by 6-inch stroke engine of the floating lever type placed in the hold below the pilot house, as shown on the inboard profile, Fig. 2. The hand gear consists of a drum in each pilot, operated by a 6-foot hand wheel, and has wire rope running below to a crosshead, to which the tiller chain is attached. This arrangement can be thrown out of gear when the steam gear is in action.

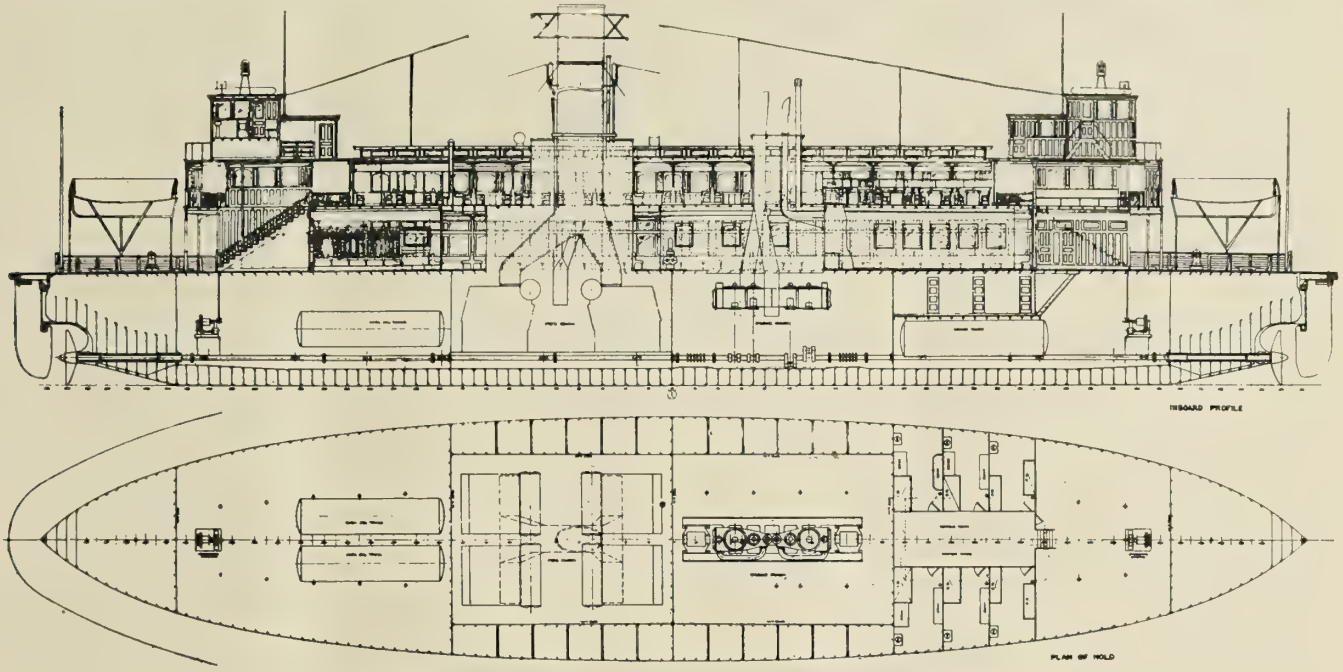


FIG. 2.—INBOARD PROFILE AND HOLD PLAN OF THE EDWARD T. JEFFERY

The propelling machinery consists of two sets of inverted, direct-acting compound surface condensing engines, with cylinders 20 inches and 42 inches in diameter by 28 inches stroke. The engines actuate a shaft carrying a propeller at each end of the ship, at a working steam pressure of 160 pounds per square inch at the throttle; the engines turn up about 150 revolutions per minute, equaling a piston speed of 700 feet per minute. At this speed the indicated horsepower is about 2,600.

The two sets of engines are coupled together, with the high-

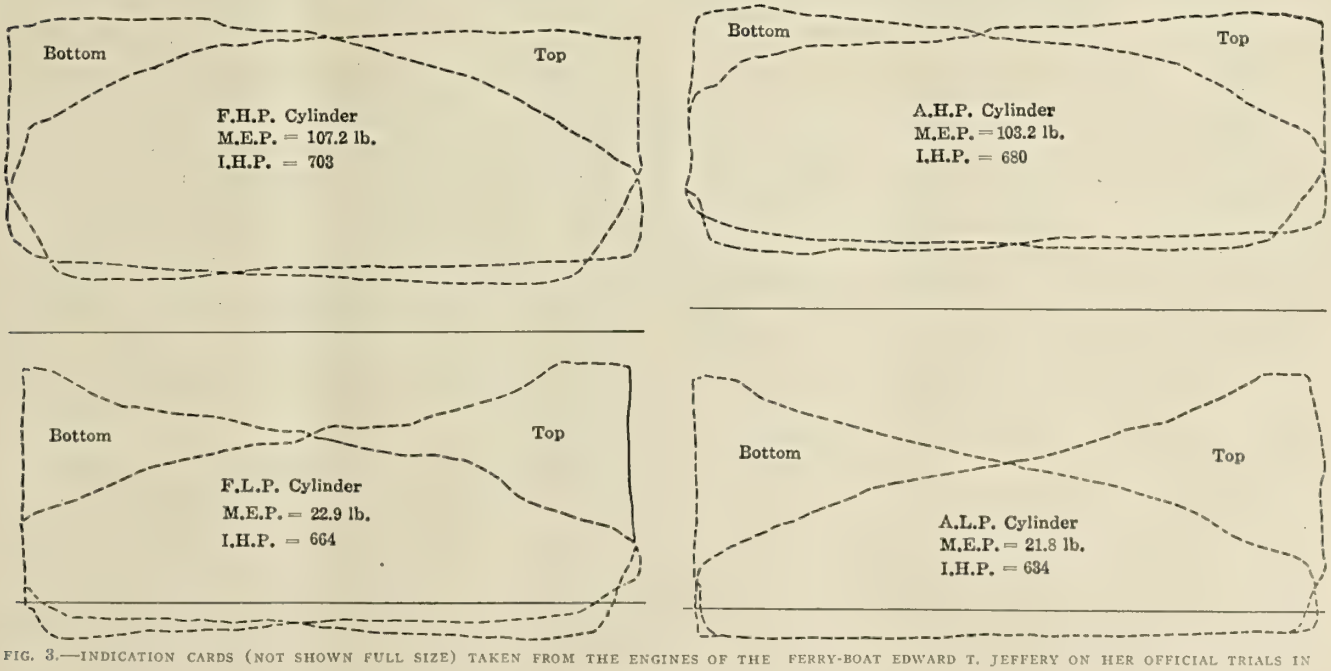



FIG. 3.—INDICATION CARDS (NOT SHOWN FULL SIZE) TAKEN FROM THE ENGINES OF THE FERRY-BOAT EDWARD T. JEFFERY ON HER OFFICIAL TRIALS IN SAN FRANCISCO BAY, AUGUST 11

pressure cylinders in the middle with cranks at an angle of 90 degrees. The low-pressure cylinders are at either end with cranks opposite their respective high-pressure cranks. Each cylinder is cast with its steam chest, and the cylinders of each engine are firmly bolted together. Furthermore, the two high-pressure cylinders are bolted together at the center. The high-pressure cylinders are fitted with liners and 10-inch diameter piston valves. The low-pressure cylinders are fitted with double-ported slide valves having the American balance. They are also provided with 8-inch diameter assistant cylinders.

Cast iron box section columns of the inverted "Y" pattern support the cylinders at the back, while at the front there are turned columns of machinery steel 4½ inches in diameter. The bedplate is of box section, cast iron, in two pieces, bolted together at the center; and into each section are formed the three main journal boxes. Extensions at each end of the bedplate take the thrust bearings.

The high-pressure pistons are of cast steel, conical dished shape and fitted with improved design clamp packing ring. The piston rods are of machinery steel, 4½ inches diameter. The connecting rods, which are 70 inches long between centers and forked at the upper ends to take the crosshead brasses, are 4 inches diameter at the upper end and 4¾ inches diameter at the lower ends. The crankpin brasses are of cast steel lined with white metal. The double forged steel crosshead pins are 5 inches diameter by 5¾ inches long. The crosshead guide, which is of cast iron 10 inches wide by 5¾ inches deep, is cored out for water circulation. All stuffing boxes are fitted with Tucker's metallic packing, and a complete water service and oil lubrication system is provided.

The valve gear is of the Stephenson type, with double bar links 1⅜ inches thick by 3½ inches deep. The link blocks are of composition, with pins 3¾ inches diameter by 2¾ inches long with gibs of composition 8½ inches long. The eccentric rods are of forged machinery steel forked at top ends and fitted with adjustable brasses. The eccentric sheaves are of cast iron, 20 inches in diameter by 3¾ inches face, and the eccentric straps are lined with white metal. Reversing is accomplished by a steam gear of the floating lever type, with a steam cylinder 12 inches diameter and water cylinder 5 inches diameter by 14¾ inches stroke.

The crankshaft is in two pieces, of forged machinery steel 9 inches diameter, and of the built-up type. The crankpins are 9 inches diameter by 11 inches long, with webs 6½ inches thick. The pins are shrunk into the webs and keyed. There is one length of thrust shaft 9 inches diameter at both ends of crankshaft. On each thrust shaft six collars are turned out of the solid, 17 inches diameter by 2 inches thick, with a 4½-inch space between the collars. Thrust collars of usual horseshoe type, faced with white metal and cored out for water circulation, are provided. The line shaft is 9 inches diameter, rough turned, except at spring bearings, where it is finished. The propeller shaft, 9 inches diameter, is of forged steel with composition liners. Between the liners the shaft is painted and covered with canvas and wrapped with marlin laid in pitch. Cast iron stern tubes are placed at each end of vessel and lined with lignum vitæ staves.

The engine jacking gear consists of a cast steel worm wheel keyed to the crankshaft and operated by a bronze worm fitted in a bracket on the bedplate.

Both the bow and stern propellers are right-hand screws of solid cast iron, four-bladed. They are 9 feet 9 inches diameter by 12 feet pitch, with a pitch ratio of 1.19 to 1. The helicoidal area of the four blades is 40 square feet, and the blades are of pear shape thrown back 12 inches at the tip, which is abnormal, but which has been found to give better efficiency for the bow propeller, which is backing when the ship is going ahead.

Steam is supplied by four boilers of the Babcock & Wilcox watertube type, designed for a working pressure of 200 pounds per square inch. The boilers are 13 feet 9 inches long, 11 feet 7 inches wide and 11 feet 3 inches in height, with 42-inch steam drum by 12 feet long, made of ½-inch plate. The tubes are 2 inches and 4 inches in diameter, of No. 10 and No. 6 B. W. G. thickness, respectively. The total heating surface of the four boilers is 10,000 square feet, and the total grate surface is 234 square feet. The waste gases from the four boilers pass into one stack of an elliptical section, with inside dimensions 4 feet 6 inches by 8 feet, which extends 57 feet above the top of breeching and is double throughout.

The exhaust from the low-pressure cylinder of each engine is led to one main condenser with 52 inches inside diameter, containing 2,708 square feet of cooling surface, provided by 1,825 ⅝-inch tubes 9 feet long between the tube sheets. There is a feed-water heater with 200 square feet of heating surface, into which the exhaust from all the auxiliaries is led. The pressure in the heater is regulated by a back pressure valve fitted on top of the condenser.

The two main boiler feed pumps are of the Blake vertical simplex type, having steam cylinders 12 inches diameter, water cylinders 7 inches diameter with a common stroke of 12 inches, controlled by a float in the feed and filter tank. The air pump is a Blake single-acting twin beam pump, with two steam cylinders 9 inches diameter and a common stroke of 12 inches. Attached to the beam of the air pump is a plunger pump 1¼ inches diameter by 12 inches stroke, provided with a ½-inch suction to main engine crank pits to discharge the waste lubricants into the stern tubes at each end of the vessel. There is a centrifugal circulating pump with 12-inch suction connected to the sea or bilge, which circulates water through the condenser and overboard. The pump runner is of composition, 32 inches diameter, with a 2½-inch mouth. The driving engine has cylinders 6 inches and 12 inches diameter by 8 inches stroke, and operates at 300 revolutions per minute. The bilge pump, which is a Blake horizontal duplex, with cylinders 6½ inches, 4 inches by 6 inches, is located in the engine room, and connected to the bilge suction manifold box for pumping out all holds, peak tanks, engine and fire-room bilges. This pump is also connected to the sea and can pump into the fire main. It is also fitted to circulate water through the condenser. There is a horizontal Blake duplex fire pump with cylinders 10 inches, 7 inches by 12 inches, located in the engine hatch off the main deck, which pumps into the fire line and supplies water to eight 50-foot hose reels, so distributed as to reach all parts of the vessel. The fire pump is also fitted to pump from the bilges and to circulate water through the condenser. There are also two hand deck pumps, 4 inches diameter by 5 inches stroke, and connected to the sea and to hose reels, one at either end of the house on the main deck. The fresh-water pump is a Blake horizontal duplex, with cylinders 5¼ inches, 4¾ inches by 5 inches stroke, connected to fresh-water tanks in the hold aft of the engine room and discharge into a tank on the hurricane deck provided for drinking faucets and galley use.

The boilers are fitted for burning fuel oil, the "Owens" steam burner being used. Fuel oil is carried in two tanks, 6 feet diameter by 26 feet long, in the hold forward of the boiler room. Two oil pumps, horizontal duplex, with cylinders 5¼ inches, 4¾ inches by 5 inches, provided with suction and discharge strainers, discharge through a cast iron heater fitted with a steam coil of 15 square feet heating surface. The oil pumps are controlled by a regular pump governor.

The electric generating set consists of two 20-kilowatt General Electric Company marine type sets, driven by reciprocating engines.

On the official trial trip, which was run Aug. 11, the engines and boilers showed up to the best advantage. The maximum indicated horsepower, as may be seen by the cards accompanying (these cards show the average indicated horsepower) this article, was 3,100 at a speed of 165 revolutions per minute of the main engines. The average of six trials over the measured

course on San Francisco Bay was 14.97 knots, or 17 miles per hour.

The plans of the hull and the specifications were drawn up by Mr. J. H. Hopps, of San Francisco, consulting engineer for the Western Pacific Railroad Company.

## The New Liverpool Dock

BY TH. OSBORNE

The continually increasing American traffic has necessitated the construction of an enormous additional dock at Liverpool, which has just been declared open with befitting ceremony by the King.

To a casual observer, a dock is almost too simple and obvious a structure to seem requiring any very great experience and study, but more detailed consideration must show quite the reverse is the case, more especially of very large modern docks, which, in addition to providing safe quayage for vessels, must be equipped with machinery and structures thoroughly designed to accomplish the loading, discharging and dispatch of cargo and passengers with safety and due economy of time and money; moreover, the repair of ships must also be facilitated. Beyond all these considerations there is the basic scheme of the docks as a unified system and as part of the commercial facilities of the great port and the country as a whole. The position and design of each dock and of all its equipments must fit in harmoniously with this basic scheme.

The great new dock, named the Gladstone Dock, has been essentially planned to be a graving dock for the repair and overhauling of those vast vessels which are now provided for the transatlantic traffic, and for the still larger ones, which many predict will be constructed before this dock will have been in existence for many years. When it is not engaged for this purpose it will be available as an ordinary wet dock for loading and discharging cargo and stores. The largest ocean liners at Liverpool are not generally taken into the docks to discharge their passengers, who generally leave via the great Prince's floating landing stage. The new dock, while therefore of suitable length, is intentionally narrow in comparison with the larger of the wet docks, as it is only intended to hold one vessel at a time, whereas a wet dock would have width for ships at each side wall in addition to passageway along the center.

The new dock is 1050 feet long inside the sliding caisson, or gate, and there is an entrance 120 feet wide. The width of the dock itself is 141 feet in the lower part, spreading out to 155 feet 6 inches wide at the water level. The walls are vertical, and the increased higher width is obtained by their being stepped in two places, so as to provide dock facilities. The depth over the entrance sill is no less than 46 feet at high water of the ordinary spring tides. This dock was originally designed to provide for vessels of the type of the Cunard liner *Aquitania* and others expected to follow; it is therefore desirable to recall the fact that this vessel is 902 feet in length over all, with a width of 97 feet. Her loaded draft is 34 feet, but this might be increased should the vessel at any time be damaged. Moreover, the general policy of naval architects is tending to designing vessels of even greater draft, whenever the harbors intended to receive them can be improved sufficiently to provide the necessary depth of water.

In accordance with its dual character, although the new dock is essentially intended to be a graving dock, it has been provided along one side with a one-story transit shed for cargo and stores. It is, moreover, a portion of a more comprehensive scheme designed to include two large branch docks, respectively 1,300 and 1,325 feet long and 400 feet wide, intended to be placed in the space south of the present dock and the Hornby dock, which up to now has been the most northerly of the great range of Liverpool docks. It is intended that these two branch docks will open into a Gladstone half-tide dock with two lock entrances pointing up river, and they will also be connected with the Hornby and other docks. When this great dock system will have been completed, the longest quay will provide facilities for a ship no less than 1,500 feet in length without interfering with maneuvering in the half-tide dock.

Still further north along the shore, the Liverpool Dock Board possesses an extensive area of land available for future dock development, so that the increase of the great port in the estuary of the Mersey is amply provided generations ahead.

It is doubtful whether any other European harbor can compare with that of Liverpool, now that the bar has, at enormous cost, been dredged; the docks are virtually non-tidal, and by far the larger number, which are constructed in groups, have been provided with tidal or half-tidal basins. A tidal basin is practically a sheltered collecting basin for shipping, as vessels are able to enter and leave the dock with greater safety than when they enter directly from the flowing tidal water. It is important to note that tidal basins are particularly advantageous where there may be several ships wishing to enter or leave about the same time. In several instances, the tidal basins may have gates at both ends, so as to convert them into huge locks, but in most they are completely tidal. A half-tidal basin, of which there are several, is always provided with tide gates, which are usually open for, say, two hours, more or less, before high water until some little time after full tide. In the projected Gladstone half-tide basin the river entrances will be large, full-sized locks, so that the fluctuation in level of the basin will not be very great.

European ports vary; some of them are not subject to high tides, and in such cases the docks may be perpetually open to tide water, provided, of course, that the docks are efficiently protected from rough weather. A breakwater is the ordinary protection. A typical instance is the docks at Marseilles, fronting the Mediterranean, also Milwaukee, Toronto and other ports on the Great North American Lakes. The open dock is very generally found along the Northern American coasts, where the great ports frequently have sheltered harbors, combined with very slight tidal fluctuations. New York, Philadelphia and Boston may be mentioned as interesting examples, the docks being formed for the major portion by a series of jetties, often of timber, projecting into the rivers. This system of harbor construction has the advantage of not involving any exceptionally large outlay of capital, but it is most suitable for a wide estuary, for unless the river is a very wide one it restricts the channel very seriously, and in that event the docks require to have a greater or less portion of their length excavated out of the shore.

Along the west coast of Europe, including Great Britain, open docks are not possible, but Southampton is a noteworthy exception. On the other hand, a very large outlay is necessary to provide each individual dock with its own gates and locks. Properly engineered docks are now practically invariably arranged in a group branching from an extensive basin, with ample space for the movement of vessels, this in turn communicating by means of locks and gates with tide water. This system, it will be noted, has points of resemblance with the sheltered open docks of Marseilles, the main difference being that the passageways through the breakwater at Marseilles do not require gates or locks.

Assuming that there is an ample depth of water, then, obviously the simplest and most economical construction is the shore quay or wharf, generally seen along the banks of rivers and lakes, but they are only applicable for a limited traffic, sheltered water and reasonably small tidal fluctuations of level. The system yields a minimum of accommodation for a given frontage, but it has advantages where ships have to leave at

all times, and frequently also where the tidal conditions would make this almost impossible with ordinary docks.

Both systems can be seen side by side at Liverpool, where there is an obvious want for a riverside quay, in addition to the docks, for passenger steamers, more especially the ferry-boats and steamers crossing to Ireland or traversing the Irish Sea in various directions to Scotch and English ports. It is scarcely necessary to describe here how cleverly this requirement has been met, in spite of the great tidal fluctuations, ranging up to 31 feet by the widely-known Prince's floating landing stage, which is connected by means of hinged roadways with the shore.

In Great Britain the construction is generally of a very substantial and permanent character, with the minimum of timber and other semi-perishable materials. This applies to both graving docks and wet docks. Not very long ago prominent engineers somewhat severely criticised British dock construction. It was suggested that it was too substantial, and by its very permanency retarded development in ship construction, so far as related to their length. It must be admitted that this criticism is not without some justification, but in the case of a growing port it should be remembered that as the ships increase in size, so too, usually, does the trade of the port, and in any event, therefore, new docks have from time to time to be constructed, each providing for the requirements of the day. The natural consequence is that the more recent docks are planned to accommodate the largest vessels, while all the remainder can be comfortably accommodated in the older docks. Thus, comparatively few of the Liverpool docks have become useless because of the growth of shipping, although some have been modified or removed to provide space for shore improvements. Even graving docks seldom cease to be abundantly serviceable after the largest ships have become too large to enter them.

After increased dimensions, probably the most striking development in dock equipment during the last decade or so has been in the more ample provision of mechanical handling appliances, both on the quays and in the transit sheds themselves. The old hand cranes have long since disappeared, and have been replaced by steam, electric or hydraulic cranes, hoists and capstans, and even to endless traveling bands for handling baggage, grain, coal, ore and other bulk cargoes. Excepting American ports, Liverpool is probably the best equipped and most up-to-date port of the world.

# New Pacific Liner Built at Newport News

The *Matsonia,* a steel single-screw steamship, to be completed in October by the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va., is the latest addition to the Matson Navigation Company's fleet, and is intended to maintain a regular service between San Francisco and Honolulu, Hawaii.

She will be equipped for carrying a large amount of cargo, and also is provided with modern and up-to-date quarters for the accommodation of 246 first class passengers and 78 steerage passengers, as well as a crew of 121 officers and men.

The ship has been constructed in full accordance with Lloyd's Register of Shipping, Class +100-A1. The leading particulars of the vessel are:

| | |
|---|---|
| Length, over all | 500 feet |
| Length between perpendiculars | 484 feet |
| Breadth, molded | 58 feet |
| Depth, molded to shelter deck | 44 feet 9 inches |
| Sea speed, loaded to 24-foot draft | 16 knots |
| Displacement at 24-foot draft | 13,500 tons |

The machinery is located aft, as on the other vessels of this line. The cargo will be carried forward of the machinery space below the upper deck and in the portion of the upper 'tween decks forward of the dining saloon. Provision is made for carrying a large supply of fuel oil, the lower part of the forward hold being arranged for fuel oil storage, as well as the double bottoms, which are made deeper than usual, and the forepeak. Amidships, in the hold, is a tank for carrying over 200,000 gallons of molasses, with pumping plant adjacent. This tank is also arranged for carrying fuel oil on emergency. A large space on the lower 'tween decks is fitted up for carrying refrigerated cargo, and the upper 'tween deck forward is arranged especially for the carriage of bananas. The total space available for cargo is about 450,000 cubic feet, exclusive of the molasses tank.

The upper deck amidships, as well as two tiers of houses above the shelter deck, are devoted to the accommodation of passengers. The deck officers' quarters and pilot house are located in a teak house above the passenger quarters. On the shelter deck aft are located the purser's office and Marconi rooms. The seamen's quarters are located in the forecastle, while aft on the upper and shelter decks are located quarters for the engineers, stewards' department, etc. On the shelter deck is provided a social hall forward, with deck houses aft, containing staterooms opening onto a wide and spacious promenade extending the entire length of the vessel. Below on the upper deck and well forward is the dining saloon; aft of which are first class staterooms, toilets, pantry, galley, and farther aft are spaces for steerage passengers. On the bridge deck, forward, is the smoking-room, and aft of this are located additional staterooms, wherever possible, arranged in suites.

For the safety of those on board, watertight subdivision is provided by a cellular double bottom, 5 feet 6 inches deep, extending the full length between peak bulkheads, as well as by seven transverse watertight bulkheads. Ballast is provided for in the cellular double bottom, which is subdivided into tanks aft for the storage of fresh water, while forward the space is devoted to the storage of fuel oil.

### Hull Construction

The vessel is constructed on the ordinary transverse frame principle—10-inch channels being spaced 28 inches on centers in general, except somewhat closer in the forehold, and in the fore and aftpeaks, where 8-inch channels are spaced 24 inches on centers. Three side stringers are fitted in the holds on either side. The floor plates in the cellular double bottom are fitted on every frame. The deck beams vary, being 8-inch channels for main deck, 7-inch channels for upper and shelter decks and 6-inch angles for the bridge deck, fitted to every frame, while in the bridge deck house 4-inch angles are spaced 30 inches on centers.

Two rows of wide-spaced pillars and girders are adopted in holds on the main deck and on the upper deck aft of the passengers' quarters, but throughout the passenger quarters smaller stanchions are used. A bilge keel extends on each side for a length of 250 feet amidships.

### Propelling Machinery

The propelling machinery consists of one four-cylinder, triple-expansion engine, of 8,500 indicated horsepower at 80 revolutions per minute, with cylinders 35 inches, 61 inches and two 81 inches in diameter, having a 66-inch stroke. The propeller is of the right-handed built-up type, with manganese

bronze blades and a cast iron hub. The main condensers are of the independent cylindrical type.

### Boilers

Steam is generated in three single-ended Scotch boilers, each 13 feet 6 inches in diameter and 12 feet long, containing about 6,000 square feet heating surface, and six Babcock & Wilcox watertube boilers, containing 22,800 square feet heating surface. The boilers are to carry a working pressure of 230 pounds per square inch, but are designed and built for 250 pounds, and operate with oil fuel, mechanically atomized, under natural draft.

The oil fuel system is of the Newport News Shipbuilding & Dry Dock Company type, which has been developed by considerable experiment at the shipyard. This system has been fitted to several of their recent ships, and has given extremely satisfactory results under both natural and forced draft.

An elaborate outfit of machine tools is fitted in the engineer's workshop, and the full complement of oil tanks for the engine room are of sufficient capacity for carrying lubricating, cylinder, refrigerating engine oils, etc., for a sixty-day run.

### Auxiliaries

The auxiliary machinery consists of one centrifugal circulating pump, an independent air pump, two independent direct-acting feed pumps, two 25-ton evaporators, a distiller, feed filter and heater, bilge and ballast pumps of large capacity and general service, sanitary and various other pumps. The steering gear is of the Brown steam tiller type, and is equipped with complete telemotor control.

The ship is heated and thoroughly ventilated throughout. The system of heating is the usual two-pipe steam arrangement, with radiators in the social hall, ladies' lounge and writing room, while in the dining saloon and smoking room sill heaters and seat coils are installed. Electric heaters are provided for the staterooms.

For forced ventilation, one fan supplies fresh air to the staterooms on the upper deck and another to the fruit cargo spaces. Five other fans thoroughly exhaust all foul air from galleys, toilets and cargo spaces, and serve to ventilate the dining saloon and other spaces below decks.

Electricity for lighting and power purposes is supplied by two 30-kilowatt and one 50-kilowatt engine-driven generators.

The refrigerating plant is equipped with two 10-ton refrigerating machines with all necessary piping and cold-storage rooms. Drinking water is circulated through coils to the public spaces.

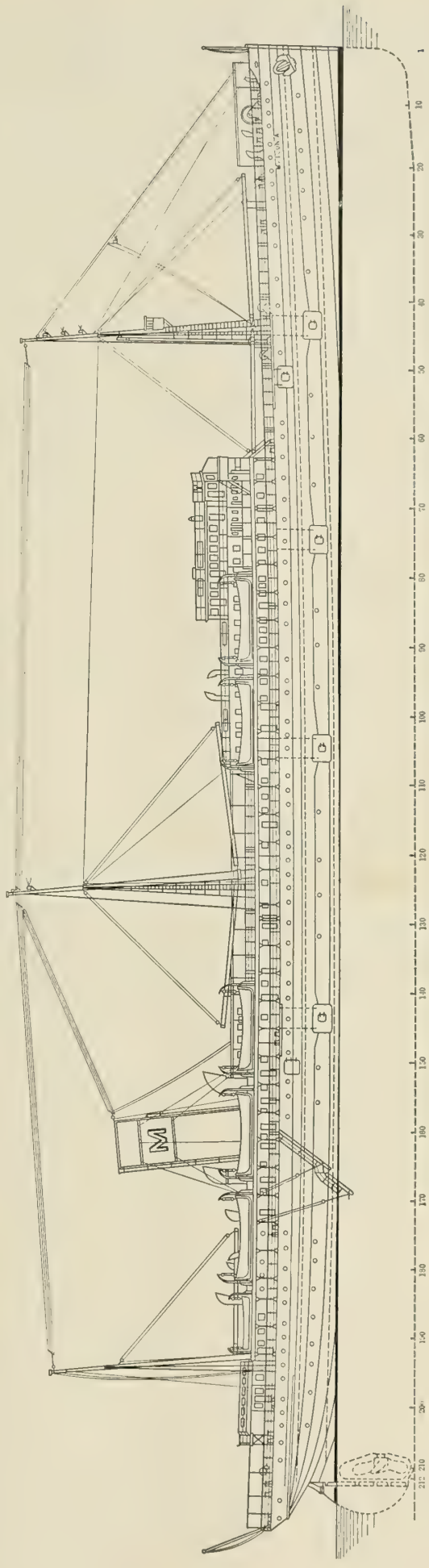
Lifeboat accommodation is provided for all on board by means of nine 28-foot metallic double-ended boats and one 28-foot wooden power boat for towing the fleet of lifeboats. In addition there will be a work boat. All are carried under Welin quadrant davits.

### Cargo-Handling Appliances

For loading and discharging cargo the ship is provided with two cargo ports on the upper deck and four on either side on the main deck, as well as two cargo hatches forward on the shelter deck, and two trunk hatches located about 'midships on the bridge deck. The last two will be supplied with electric elevators for the handling of sugar cargoes.

To the foremast are attached four 8-ton booms and one 50-ton boom, to the mainmast four 8-ton booms, all for handling cargo, while to the mizzenmast is attached one 8-ton boom for handling engine room weights. The booms on the fore and mainmasts are operated by means of eight 7-inch by 10-inch steam winches, four to each mast, while the boom on the mizzenmast is operated by means of an 8-inch by 10-inch steam winch.

A powerful steam windlass with vertical capstan attached is located forward.



PACIFIC LINER MATSONIA OF 18,500 TONS DISPLACEMENT AND 16 KNOTS SPEED, BUILT BY THE NEWPORT NEWS SHIPBUILDING & DRY DOCK COMPANY FOR THE MATSON NAVIGATION COMPANY

### Passenger Accommodations

About 'midships on the upper deck are located spaces for the accommodation of steerage passengers. The rooms are large and roomy, and special attention has been given to their ventilation.

Forward of these rooms and completely separate from them are first class staterooms. These, together with the ones located in the deck houses on the shelter and bridge decks, are paneled in a simple design in white. The white enameled berths, the mahogany furniture, the green carpet, all combine with the cretonne window hangings in giving a very cool and restful effect.

Wherever possible private baths are arranged, and all rooms are arranged conveniently to bath rooms. In many cases rooms adjoining are so arranged that they may be thrown into private suites.

Ten special staterooms are provided, each with its own bath and finished in an individual style of decoration. There are two suites paneled in bird's-eye maple, the long panels displaying the natural beauties of the wood to great advantage. Six other rooms are paneled in mahogany, with mahogany or silk tapestry panels varying in tone and color, and two are finished in white Colonial, one with blue and the other with pink silk tapestry panels. The special rooms are all fitted with heavy brass bedsteads and other specially designed furniture in mahogany.

In addition to these there are eight other rooms finished more elaborately than the ordinary first class staterooms, but not quite as elaborately as the special rooms.

The officers' quarters on the bridge are neatly and tastefully treated, and the captain's room forward is in close proximity to the wheel-house, which is modern in every particular and fitted with every known appliance for ship control.

### Public Spaces

Well forward, and extending across the ship on the upper deck, is the dining room, arranged to accommodate 206 persons at one sitting. The style of decoration is of the late Renaissance period. There is a wainscot of mahogany surrounding the room, surmounted by a pleasing arrangement of paneling, enriched here and there by ornament in low relief. The color scheme above is carried out in a series of grays, ranging from a rich warm tone to the almost pure white ceiling. Wide-spaced stanchions are enclosed in mahogany, richly carved, harmonizing with the carved pilasters all along the walls. The beamed ceiling is supported at these columns by carved consoles, and at the forward end is the mahogany sideboard of massive yet refined proportion.

At the forward and after ends are alcoves which may very well serve for dinner parties, affording that privacy sometimes so much desired. The tables are small and arranged to allow all necessary space and to avoid the appearance of being crowded, as is generally the case on passenger vessels.

An innovation has been introduced in placing a buffet at the entrance to the dining saloon, where one may go between regular dining hours and obtain light lunch. On either side of the dining room light enters through a series of cathedral glass windows, which suffuse the light into a warm glow over the entire room. These sashes are provided with ventilating grilles, and these, together with a system of exhaust ventilation, will keep the room cool at all times.

Immediately aft of the dining saloon is the stair hall treated in modern English. This same hall is carried up for three decks, and the spacious stairways connecting same have wrought iron grilles of simple design. The walls are paneled in mahogany, large panels being used, which in their very simplicity only serve to enhance the rich grain of the wood and to emphasize the beauty of the smaller carved panels, which are fitted in combination with them. Over the stair leading to the bridge deck is the ship's clock, handsomely mounted in a large carved panel.

On the shelter deck forward of this stair hall is the social hall. The style here adopted is of the period known as Empire, with mahogany paneling and gilt ornament, enriching the warm color of the mahogany and bringing out the quiet dignity of the period it represents. The furniture, quietly designed and faithful to the period and upholstered in dark green tapestry and silk brocade completes the desired effect.

At the forward end of the social hall are alcoves filled with palms and ferns, bringing a touch of life and sunshine to those within. A pianola is also placed at the disposal of the passengers and for use in special concerts.

Just aft of the social hall, and to either side, are the ladies' lounge and the writing room. These rooms are treated in the French style prevalent in the time of Louis Seize, a style which affords an especially rich treatment of wall surfaces, with panels and the light and elegant mouldings common to the period. For the ladies' lounge the color scheme is carried out in old ivory and blue, the wall panels being of a blue figured silk tapestry. The furniture is of mahogany and upholstered in a heavier tapestry of harmonizing color, and the carpet in brown gives the sufficient background to the setting. Even the silvered lighting fixtures have been especially designed and are faithful to the period.

The writing room is similar in design and style to the ladies' lounge, but its color scheme is carried out in tones of buff and golden browns. Both rooms are separated from the social hall by French casements and are richly hung with brocaded tapestries. A number of writing desks are provided in both rooms for the convenience of passengers.

On the bridge deck, forward, and directly over the social hall, is the smoking room. Here the style followed is one of the early English styles of the fifteenth-sixteenth centuries—the Tudor gothic. The woodwork is essentially oak, stained an antique brown, and the wall panels are enlivened here and there by carvings peculiar to the period.

The idea is carried out in the arrangement also, and four alcoves are provided, with low seats facing across a heavy oak table, where one may sit, and at the alcove ends are long, narrow perpendicular windows, affording an unobstructed view out over the water. The mantel deserves especial mention. Over its mantelshelf the Royal Hawaii Coat of Arms against a robe of ermine and surmounted by the tiara is carved in solid oak, making a splendid effect. The soft tapestry window hangings add a touch of somberness to the whole, so that one unconsciously feels the spirit of the times it is intended to represent.

It has not been the aim of the decorators to impress the passenger with a false magnificence, but rather to surround him with that quiet simplicity which goes far toward making the sea voyage the delightful event it should be.

The ship as a whole may be well said to be a long step in advance of anything yet attempted for the trade in which she will engage. Her hull, machinery, cargo-handling appliances and interior arrangement and decorations each represent a vast amount of study on the part of the owners and builders, and it is confidently expected that the traveling public will rapidly discover and approve of the effort in their behalf.

The vessel is fitted with foundations for four 6-inch guns, and otherwise arranged as a vessel of the second class under the Postal Subsidy Act of March 3, 1891, to which class she is entitled on account of her size and speed.

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A Course of Aerodynamics at the Massachusetts Institute of Technology.—Upon the request of President R. C. Maclaurin of the Massachusetts Institute of Technology, Boston, Mass., the Secretary of the United States Navy has detailed Assistant Naval Constructor Jerome C. Hunsaker for work at the Institute in developing courses in aerodynamics.

# Design of Propellers for Geared Turbines

BY PETER DOIG

The recent remarkable results in enhanced economy, by the use of mechanical reduction gear applied to high-speed turbines, render the question of the determination of a suitable combination of turbine, gear and propeller one of immediate interest.

Geared turbine propulsion may be claimed to be well advanced in, if not beyond, the experimental stage. There are now in actual service cargo steamers, Channel steamers and warships, representing over 30,000 brake horsepower developed by steam turbines and transmitted through mechanical gearing, while over 120,000 brake horsepower is being built. The subjoined table gives the main features of some of those vessels of which particulars have been made public:

| Name. | B. H. P. One Shaft. | R. P. M. Turbine. | R. P. M. Screw. | Ratio. | Speed, Knots. |
|---|---|---|---|---|---|
| Vespasian..... Single screw. | 1000 | 1500 | 75 | 20.0 | 10.5 |
| Cairnross..... Single screw. | 1600 | 1700 | 65 | 26.1 | 10.5 |
| Neptune..... Twin screw. | 3000 | 1200 | 132 | 9.1 | 14.0 |
| Normannia..... Twin screw. | 3000 | 1500 | 300 | 5.0 | 20.0 |

The problem of fixing the revolutions of the prime mover and the ratio of reduction to the secondary or propelling agent is one into which a series of variables enters. These may be stated as follows:

1. The steam economy of the turbines which, within limits, is greater with higher revolutions.

2. The size (volume) and weight of the turbine resulting from the revolutions adopted for it, this being approximately inversely proportional to the square of the number of revolutions.

3. The size and weight of reducing gear, which is greater with large ratio of reduction, efficiency of transmission being practically independent of this ratio.

4. The propeller efficiency obtainable, which is generally greater with moderate than with high revolutions.

At present, for units of moderate power, the range of revolutions with mechanical gear is from about 1,500 to as high as 3,000 per minute, as, for instance, in the three 260-foot vessels for the Ceylon ferry route recently under construction. It would appear that the superior steam economy of very high-speed turbines, with the direct fuel economy resulting, will be the consideration of greatest importance in the future, and that the consequent weight-saving in main turbines, boilers and fuel should more than offset the greater weight due to gears of large reduction ratio.

One of the first points to be raised in a design is the question of subdivision of power, which will be settled by considerations of the amount to be transmitted per gear, the superior safety of multiple screws over single screw, the resulting over-all efficiencies to be expected, and the space occupied and the cost of the installation.

As a preliminary consideration of the question the propeller problem may be first investigated. The accompanying chart has been prepared from Figs. 4 and 5 of the paper in the June number of International Marine Engineering, page 243, and shows the pitch ratio, revolution coefficient, and efficiency of the best wheel of any given diameter absorbing a certain power at a particular speed; the ratio of helicoidal to disk area being .40. The curves are plotted on a base of diameter coefficient which is a function of diameter, speed and power, being:

$$C_d = \frac{DS_a}{\sqrt{\frac{H_d}{S_a}}},$$

$S_a$ and $H_d$ to be computed as described in the paper referred to.

The question of single or multiple screws being settled by a consideration of the factors already mentioned, it is possible by means of these curves to find the diameter of maximum efficiency, assuming the size to be unlimited. This corresponds to the $C_d$ value 23.5, at which base value the efficiency curve reaches its highest point.

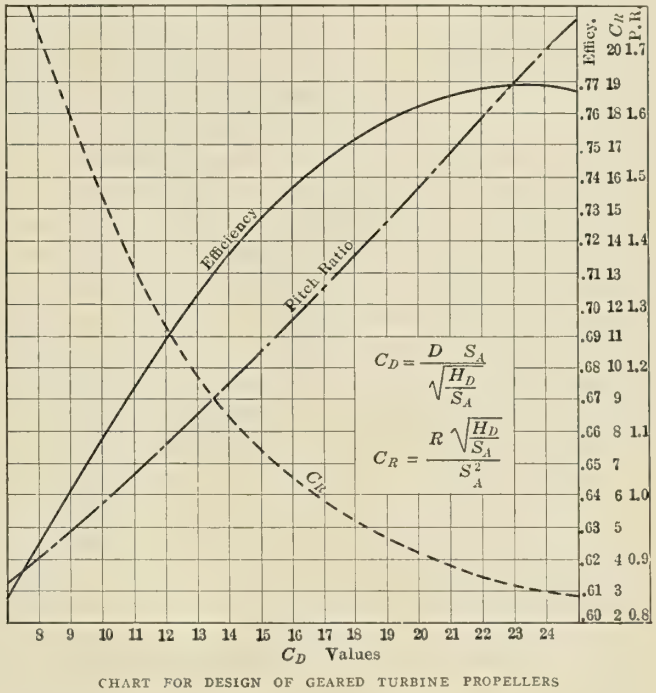



CHART FOR DESIGN OF GEARED TURBINE PROPELLERS

Taking the four vessels of the table above and transposing the formula

$$C_d = \frac{DS_a}{\sqrt{\frac{H_d}{S_a}}} \quad \text{into the form} \quad D = \frac{C_d\sqrt{\frac{H_d}{S_a}}}{S_a},$$

the corresponding approximate diameters of maximum efficiency result:

Vespasian: $\dfrac{23.5\sqrt{\frac{800}{7.5}}}{7.5} = 32.4$ feet.

Cairnross: $\dfrac{23.5\sqrt{\frac{1350}{7.9}}}{7.9} = 38.9$ "

Neptune: $\dfrac{23.5\sqrt{\frac{2850}{11.3}}}{11.3} = 33.0$ "

$$\text{Normannia: } \frac{23.5\sqrt{\frac{2680}{18}}}{18} = 15.9 \text{ feet}$$

These diameters are, of course, impossibly large through restrictions of draft alone without any reference to the revolutions at which they would work.

Still considering the propeller *per se*, it will be observed from the efficiency curve of the chart that the largest possible $C_d$ value less than 23.5 (or largest practicable diameter with a given power and speed) should be aimed at.

Regarding the problem from the propelling machinery standpoint a method of procedure might be briefly outlined as below. The arrangement of turbines generally contemplated at present is that of a high and low-pressure turbine, one on each side of the reduction gear, into which they each engage by separate pinions. It thus results that in twin or multiple screw vessels considerable athwartship space is occupied by the main propelling gear, condensers, etc., which entails, however, relatively moderate distance apart of the screw shafts, and tends to keep down the available propeller diameter.

Approximate suitable revolutions for the practicable length and brake horsepower of the turbines having been fixed on, the size of reduction gear necessary can be gaged, and hence the breadth of space required for the whole installation sketched out and approximated. With this information a layout of the shaft lines can be made and the largest possible size of the wheel obtained from the afterbody lines of the ship. This will give a certain $C_d$ value for which the appropriate number of revolutions for maximum efficiency at that diameter can be got from the $C_r$ value on the chart. If this number of revolutions does not agree with the originally contemplated turbine revolutions and size of reduction gear, on which the athwartship shaft spacing and consequent screw diameter were first based, the procedure will be repeated, and by such approximation the maximum practicable diameter of propeller fixed. This should generally resemble the procedure in ships of high power with somewhat restricted machinery space. Or it may be that draft of water will assign the greatest possible size of wheel. This will generally be the case in single screw ships, where athwartship space will usually be comparatively unrestricted, proper immersion at all drafts, or at least as little emergence at light draft as possible, being duly arranged for.

It is, nevertheless, possible that a still smaller propeller than that arrived at by this process might be desirable if the weight-saving through extremely high turbine revolutions and reducing gear of small reduction ratio showed itself superior in its effect on the all-round economy to that of the higher efficiency of a larger screw. From consideration of some typical arrangements the author believes that the largest wheel practicable will be a feature of the best compromise in these designs.

The utility of the accompanying diagram in the design of the various factors will be best shown by examples. The two here given represent about the extremes in types of merchant work.

*Example* 1.—A Channel steamer, designed to steam on trial at 20 knots, on 6,000 brake horsepower, twin screws and 1,500 revolutions per minute of turbine being adopted.

$$\text{Here } H_d = 3{,}000 \times .94 \times .95 = 2{,}680$$

6 percent being assumed lost between turbines and propeller due to gear, thrust block and shaft bearings; .95 is power factor from Fig. 2, page 242, INTERNATIONAL MARINE ENGINEERING, June, 1913.

$S_a = 20 \times .90$ (Fig. 1, page 242, INTERNATIONAL MARINE ENGINEERING, June, 1913)
$= 18.0$

$$\text{Whence } \quad C_d = \frac{DS_a}{\sqrt{\frac{H_d}{S_a}}} = \frac{D \times 18}{12.2} = 1.48D.$$

The arrangement of machinery and shaft spacing, together with the advisability of good immersion, gives 8 feet as the largest diameter desirable.

$$\text{Hence } C_d = 1.48 \times 8 = 11.84.$$

From the diagram the best pitch ratio is 1.075, giving a pitch of 8.6 feet. The value of $C_r$ on the chart is 11.5;

$$C_r = \frac{R\sqrt{\frac{H_d}{S_a}}}{S_a^2}, \qquad R = \frac{C_r S_a^2}{\sqrt{\frac{H_d}{S_a}}}.$$

$$\text{Revolutions} = \frac{11.5 \times 18^2}{12.2} = 305.$$

As 1,500 revolutions are the designed full-power speed of turbine, a reduction ratio of about 5 to 1 is necessary. The "experimental" efficiency of this wheel would be about .69 with a disk area ratio of .40, for which disk-area ratio the chart is made.

By the method described in the writer's previous paper a comparison of propeller efficiencies is possible between the above arrangement and a triple screw direct reaction turbine drive, which would be the alternative mode of propulsion.

Here the power necessary for 20 knots would be greater, owing to lower propulsive efficiency—say 6,900 brake horsepower.

$H_d$ would be $2{,}300 \times .98 \times .94 = 2{,}120$.

$S_a$ would be $20 \times .90 = 18$ (side screws).

The revolutions of this installation would be about 550 per minute.

$C_r = 9.3$ (Fig. 6, page 244). Projected disk area ratio $= .50$ (Fig. 7, page 244).

Helicoidal disk area ratio corresponding $= .55$.

$$\text{Diameter} = \frac{9.3 \times 10.85}{18} = 5.6 \text{ feet.}$$

Pitch $= 5.6 \times .89 \times .97 = 4.83$ feet (Figs. 5 and 8, pages 243 and 244).

Efficiency $= .64 \times .94 = .60$ (Figs. 4 and 9, pages 243 and 244).

The size and efficiency of the center screw would be about the same, so that there is a relative increase in favor of the reduction gear proposition of $\frac{.69}{.60} = 1.15$, or a gain of 15 percent.

This case is about that of the *Normannia*, where the overall superiority in fuel economy is claimed to be 40 percent, due partly to increased efficiency of turbines, partly to higher propulsive efficiency of twin screw arrangement, and partly to finer form resulting from saving in displacement consequent on a lighter boiler plant.

*Example* 2.—A tramp freighter; designed speed, 10.5 knots; turbine, 1,000 brake horsepower at about 1,500 revolutions per minute.

Here the draft of water would be the determining feature in fixing the diameter of the propeller. With a draft of 19 feet this would be 15 feet, which allows for considerable variations of draft, the ship being of the tramp class.

$$H_d = 1{,}000 \times .94 \times .98 = 920$$
$$S_a = 10.5 \times .74 = 7.77$$

$$C_d = \frac{15 \times 7.77}{\sqrt{\frac{920}{7.77}}} = \frac{15 \times 7.77}{10.9} = 10.7.$$

The $C_T$ value from the chart is 13.6.

This gives revolutions $= \frac{13.6 \times (7.77)^2}{10.9} = 75$; reduction ratio being 20.

Pitch $= 15 \times 1.03 = 15.5$ feet. (Three bladed.)

The efficiency of this propeller would be about equal to one suitable for an ordinary reciprocating engined proposition. In a ship of this class the improvement in economy would be due to the superior steam efficiency and lighter machinery weights. With twin screws an improvement of about .02 in propeller efficiency could be obtained; but it is problematical if this would be worth the extra first cost and maintenance entailed.

The purpose of this paper is rather to indicate the lines on which this problem will have to be attacked, than to give a rigid method of design, which is perhaps impracticable until further practical experience has been gained. The writer trusts that this purpose has been achieved in this brief article.

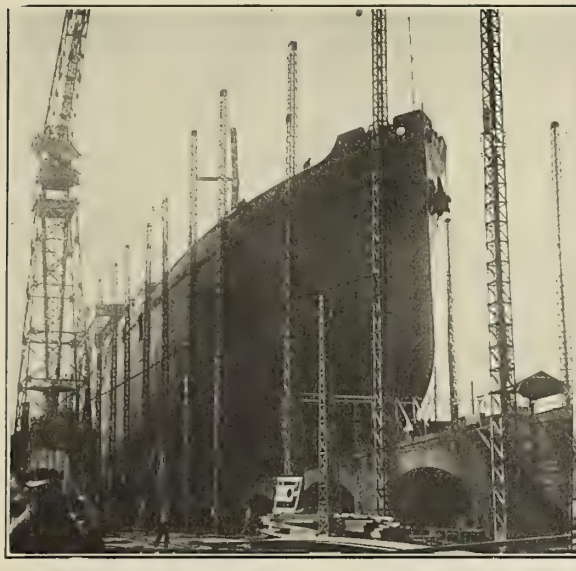


FIG. 1.—BOW VIEW OF THE CHAPLAIN

FIG. 2.—STERN VIEW, SHOWING LAUNCHING ARRANGEMENTS

## Launch of the Steamer Chaplain

The largest steamer ever launched on the river Loire is the *Chaplain*, built by Ateliers et Chantiers de la Loire in their Nantes yard. The slip on which the vessel was built is 553 feet long, with a declivity of 7 percent. In front of the slip the river is only 788 feet wide, so that in order to prevent the ship from striking the opposite quay at the time of launching, a shield with an area of 431 square feet was erected across the stern of the vessel, as shown in Fig. 2. In addition to this, heavy chains were arranged, fastened to anchors securely embedded in the ground at the bow of the ship. To these cables 120 breaking ropes were fastened, each with a breaking strength of 50 tons. With these precautions, it was estimated that, although the launching weight of the ship was 3,600 tons, she would be stopped at a distance of 132 feet from the opposite quay. As a matter of fact, the stern shield proved so effective that the ship was brought to rest after only 36 of the breaking ropes were broken.

The *Chaplain* has been built to the order of the Chargeurs Réunis for their South American service. A sister ship, to be named the *Dupleix*, is also being built at the same yard, and will probably be launched about October 1. In the near future four additional steamers of this type will be built for the same service.

The main particulars of the *Chaplain* are: Length over all, 433 feet 5 inches; length between perpendiculars, 415 feet 2 inches; beam, 53 feet 10 inches; depth to spar deck, 37 feet 7 inches; draft, full load, 26 feet 3 inches; displacement at full load draft, 12,953 tons; deadweight carrying capacity, 8,650 tons; indicated horsepower, 4,000; designed speed, 12 knots.

The hull is divided into eight watertight compartments by bulkheads worked up to the main deck. The ship is also provided with a double bottom extending throughout the length of the hull, and this is also subdivided into six separate compartments.

Steam is supplied to the main engines and auxiliaries by three Scotch boilers, with a total heating surface of 8,073 square feet and a total grate surface of 183 square feet. The boilers are operated under the Howden system of forced draft and are designed for a working pressure of 200 pounds per square inch. Fuel is carried in four wing bunkers and one cross bunker, which, together with a reserve bunker, gives a total bunker capacity of 65,670 cubic feet. A single funnel carries off the products of combustion.

The main engine is of the triple expansion type with cylinders 28, 46 and 76 inches diameter, with a stroke of 52 inches, and at 74 revolutions per minute is designed to develop 4,000 indicated horsepower in order to give the ship a speed of 12 knots. The propeller is of bronze of the four-bladed type 19 feet 5 inches in diameter.

The *Chaplain* is a spardeck vessel with three complete decks worked from end to end. The four holds are of exceptional size, in order to enable the transportation of large pieces of machinery. Hold No. 1 has a cargo hatch 21 feet 7 inches by 16 feet 5 inches and is served by a 5-ton derrick. Hold No. 2 has a cargo hatch 28 feet 9 inches by 16 feet 5 inches and is served by two 6-ton and one 20-ton derricks. Hold No. 3, which may also be used as a reserve bunker, has two hatches, each 7 feet by 10 feet, which are served by two 4-ton derricks. Hold No. 4 has a cargo hatch 24 feet by 16 feet 5 inches, served by two 5-ton derricks. Hold No. 5 has a cargo hatch 19 feet 2 inches by 16 feet 5 inches, served by a single 5-ton derrick. In all, eleven steam winches are provided for the handling of cargo.

The main deckhouse is given up to passenger accommoda-

tions, while the officers' quarters are in a separate deckhouse, above which are the chart room and pilot house. Entrances to the crew's quarters and steerage passenger accommodations are through two small deckhouses on the spar deck. Amidships are two dining rooms for the steerage passengers, one seating 190 and the other 130 persons, while at the stern is a separate dining room with a seating capacity of 50. The crew's quarters are located on the first 'tween deck, while the second 'tween deck is given over to storerooms.

## New Shipbuilding Berth and 250-Ton Wharf Crane at the Blohm & Voss Shipyard

On April 3 of this year the new 56,000-ton steamer *Vaterland,* of the Hamburg-American Line, was launched from the shipyard of Blohm & Voss, at Hamburg, Germany. Although this firm operates one of the largest and best equipped shipyards in existence, it was found necessary to provide a still larger berth and a new giant crane in order to build this immense vessel. We give herewith some data concerning this new equipment, which was furnished by the Deutsche Maschinenfabrik, A. G., at Duisburg, Germany, which we think will be of interest to the shipbuilding trade in general.

Fig. 1 shows the complete plant, consisting of three berths, of which the two on the left of the picture were built by the Deutsche Maschinenfabrik in 1906-7. These berths have a span of 115 feet and 203 feet respectively, and a height of 147 feet from the floor to the crane runway. The new berth on the right of the picture, below which the *Vaterland* is shown as it is leaving the berth, has a span of 288 feet at the water front and a height of 166 feet from the floor to the crane runway. This berth was built in 1910-1911. Only one-half of the new berth was finished to the full length of 1,025 feet to accommodate the *Vaterland,* the other half was finished to a length of 269 feet to provide facilities for the construction of a large floating dock which is being built at present and which can be seen in the foreground of Fig. 1. This half of the berth, however, will eventually be completed to its full length; the center columns supporting the left half of the finished berth will then be moved to the outside to make a berth of the full span without center columns, similar to the berth already completed.

The new berth is equipped with sixteen traveling cranes of 7½ gross tons capacity and sixteen trolleys of 5 tons capacity, running on sixteen separate runways; eight of the traveling cranes are equipped with standard trolleys and eight with Demag special trolleys of the revolving jib type. The cranes are so arranged that every point of the entire berth can be served by them, and when it is necessary to lift heavy loads four cranes can handle loads up to 30 tons. A transfer crane of 35 tons capacity shown on top of the left-hand berth can travel across all three berths and is used for transferring cranes to the tracks where they are most needed.

The lifting speed of the cranes, with the exception of the transfer crane, is 85 feet per minute. The longitudinal speeds are as follows: Traveling cranes, 140 feet per minute; revolving jib cranes, 200 feet per minute; 5-ton trolleys, 230 feet per minute. The jib cranes can make a full revolution in 40 seconds. The motors used in connection with these cranes represent over 2,000 horsepower, and are driven by direct current of 440 volts.

In addition to the new berth, a large 250-ton revolving wharf crane, shown in Fig. 2, was installed at the Blohm & Voss shipyard, as the old 150-ton derrick crane built some thirteen years ago by the Deutsche Maschinenfabrik was found insufficient for the heavy machinery that entered into the construction of the *Vaterland.*

With this crane the Deutsche Maschinenfabrik introduced a new design of the hammer type crane, having a movable jib which can be raised to an almost vertical position. This design was chosen on account of the ever-increasing dimensions of ships and the correspondingly increasing height of the masts. While the largest ships now in existence can pass underneath the jib in its horizontal position, it is expected that the luffing motion will be needed in the future. When it is necessary to raise the jib the main trolley is locked to the end of the boom, raised with same, and performs the same function as the top sheave of an ordinary jib crane.

The following dimensions will give an idea of the immense size of this new crane: The top of the runway rail is 200 feet above the water level, the maximum load of 250 tons can be lifted at a distance of 113 feet from the center of the crane. The capacity decreases with increasing outreaches, and is 110 tons at the maximum outreach of 174 feet. In addition to the main trolley, which runs inside of the jib girders, a revolving traveling jib crane of 20 tons capacity at 33 feet radius or 10 tons capacity at 59 feet radius is provided.

The lifting speeds of the large crane are: Twenty-six feet per minute for loads up to 50 tons, 13 feet per minute for loads from 50 to 100 tons, 6.5 feet per minute for loads from 100 to 200 tons, and 5 feet per minute for loads over 200 tons. The crane can make a full revolution in about 12 minutes and the jib can be raised to its highest position in 30 minutes. The auxiliary jib crane lifts loads up to 10 tons at a speed of 65 feet per minute, and loads from 10 to 20 tons at 33 feet per minute. The traveling speed is 160 feet per minute; a full revolution can be made in about 2 minutes and the raising of the jib requires about 3 minutes. The Leonard system of control is employed, and the motors together represent 550 horsepower.

By means of the small crane it is possible to pick up loads up to 10 tons at a distance of 240 feet from the center of the crane and deposit them 164 feet back of the center of the crane without revolving the main structure, covering a total distance of over 400 feet. The area covered by the crane is 181,000 square feet, or more than 4 acres. The arrangement of this traveling jib crane on top of the main structure is an innovation of the Deutsche Maschinenfabrik that considerably increases the efficiency of a giant crane, as it permits of the transportation of small loads at high speed, and makes it easy to handle masts and other parts of a ship located at an elevation. All of the Demag giant cranes built during the past few years have been equipped in this manner.

The crane is shown with the test load of 275 gross tons suspended from the main hook, and the *Vaterland* is lying alongside the quay ready to receive its boilers and engines. Only one man is needed to operate the large crane, and his cabin is located directly under the hinge of the big jib. When the small crane is working, the operator takes his place in the cabin arranged in front of the small jib, where he controls all the motions of the jib crane and also the revolving motion of the main structure.

In the illustration a man can be seen standing on the lower chord of the main jib, almost in the center of the crane, whose dimensions when compared to those of the crane give an idea of the tremendous size of this crane; it might also be mentioned that the two spindles that are employed for raising the jib are 19 inches in diameter and 65 feet long.

The Deutsche Maschinenfabrik enjoys an enviable reputation as builders of giant cranes and shipyard equipment, a proof of which is the fact that the Isthmian Canal Commission awarded them, through their agents, Messrs. Neumeyer & Dimond, New York, the contract for two 250-ton revolving floating cranes, which are under construction at present.

FIG. 1.—BUILDING BERTHS AT THE BLOHM & VOSS SHIPYARD, HAMBURG, GERMANY

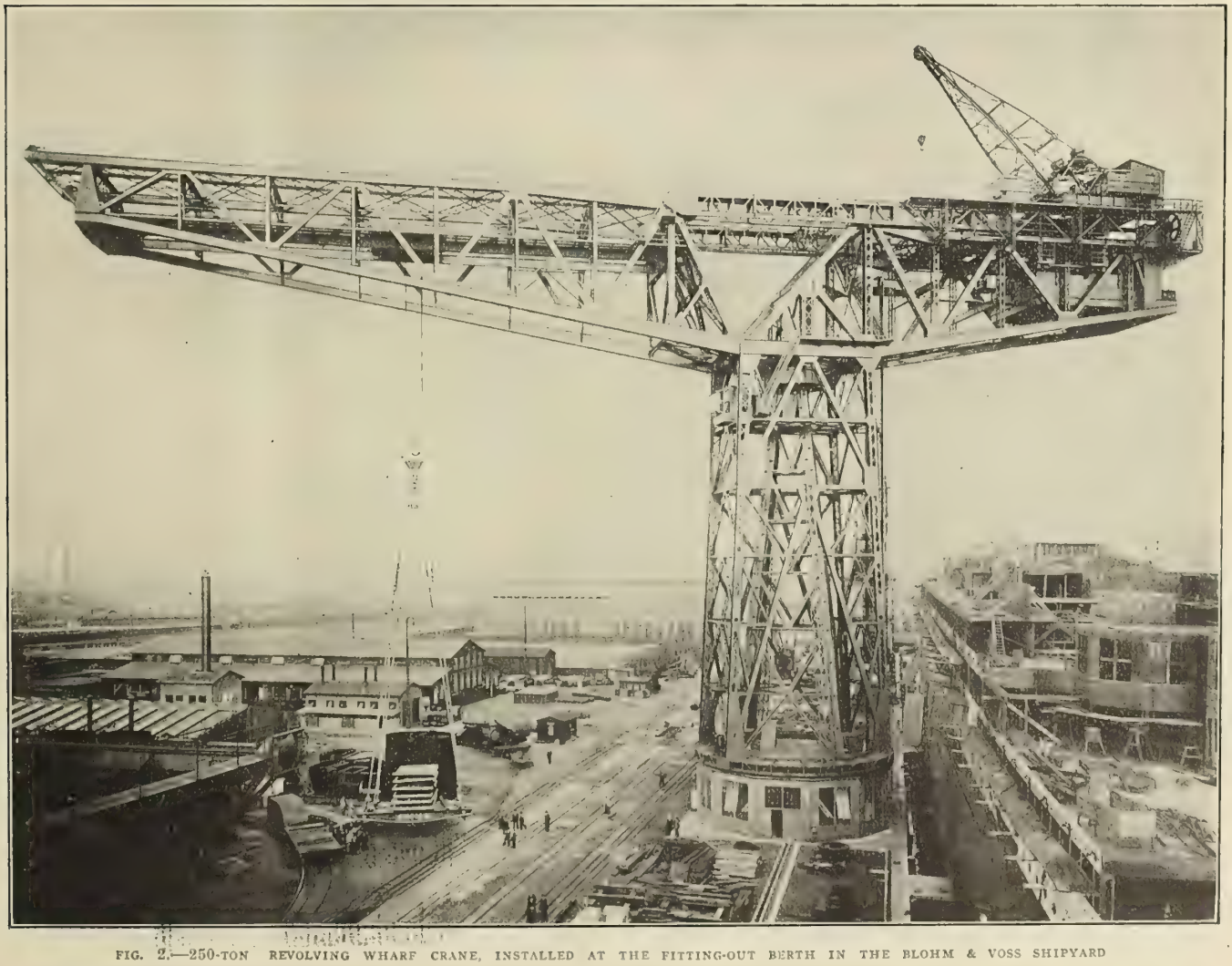


FIG. 2.—250-TON REVOLVING WHARF CRANE, INSTALLED AT THE FITTING-OUT BERTH IN THE BLOHM & VOSS SHIPYARD

# On Shipbuilding Contracts*

BY L. PESKETT

To members of the Institution of Naval Architects, the relationship that exists between the shipowner and the shipbuilder is one of peculiar interest, as the enterprise of the owner has considerable influence on the activity of the builder, the function of the naval architect being that of technical ambassador between the two. In this capacity he carries a burden of anxiety, for it is his duty to attain the realization of those Utopian ideals which the owner invariably associates with a characteristic dread of expenditure, by obtaining from the builder a ship complete in all its details, and of full value for the amount expended.

It needs but little thought to appreciate that it is in the best interests of our country to keep the cost of production within reasonable limits. When, at the launch of the *Aquitania*, the chairman of the builders' company asked for support in the formation of a combination among shipbuilders, he was appealing on behalf of a system which is the antithesis of healthy trade. The ultimate effect of any such combination is to increase the cost of production, which would be disastrous to the shipbuilding industry. The shipbuilding markets of the world are gradually altering their attitude with regard to Great Britain, and countries that at one time relied upon her to build their ships are now successfully competing with her in obtaining orders, even from British owners. The maintenance of both our shipowning and shipbuilding supremacies depends on the fundamental principle that the owner must only pay that price to the builder which is sufficient to assure him a fair and reasonable return. This is essential if the shipbuilding industry is to remain our inheritance, for every increase in the cost of production assists others in wresting it from us.

It will be well when those who control the various trade unions come to realize this important fact. Labor troubles have of late years been a source of great anxiety to shipbuilders. The time devoted by the heads of firms to the settlement of petty disputes has meant a reduction of efficiency in the conduct of their business. A solution of these difficulties might be found in the establishment of a disinterested tribunal, whose judgment in all cases should be agreed to mutually. The time at present spent in settling disputes could be more profitably employed by imitating the procedure of owners and their superintendents, who periodically hold international meetings to discuss details in connection with the work in all departments of their business.

The object of the owner when negotiating for the construction of a ship is to obtain the best revenue-producing asset it is possible to get for the sum he intends to invest. The leading shipowning companies prepare their own plans and specifications, upon which builders are invited to tender. The tenders thus received are comparable, being all prepared on a common basis.

The contract, as usually drawn up, specifies a certain fixed sum to be paid for the construction of a ship of given dimensions and speed, to be built to the requirements of the owner, and in accordance with the regulations of a particular registration society. Compare this with the procedure followed when contracting for a building.

When a building is to be erected, plans and specifications are prepared by an architect. When these have been approved, they are passed on to a quantity surveyor, who prepares a bill of quantities. Prices are then obtained for the supply and erection of the various items, based on some standard of measurement. When the building is finished the actual amount of work done is measured by the surveyor, and payment made on this assessment to each contractor at the rate previously

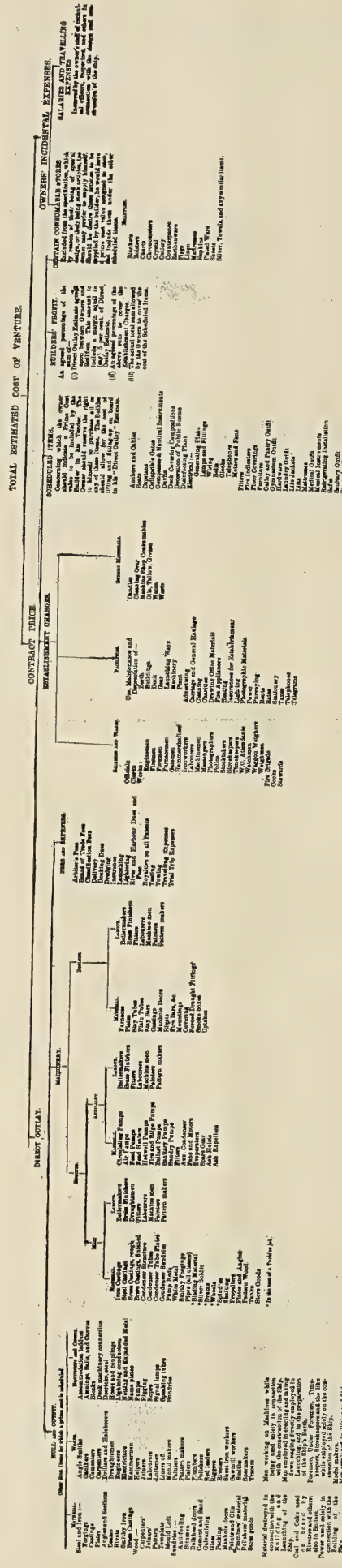



TABLE I

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

agreed upon. By this method the owner of the building may during the progress of the construction decide to add to, or take from, any of the scheduled items, with the knowledge that there will be a corresponding addition or reduction in the final cost.

There appears to be no reason why such methods should not be applied to shipbuilding. At the present time every firm has its own particular method of preparing estimates, but it should not be a difficult matter to arrange a suitable standardized form for computing the cost. If such a plan were adopted, the various tenders could be submitted on a standard basis. For example, all the items in connection with the cost of material and labor, establishment charges, profit and margin, could be scheduled, and a total sum defined as the maximum price which the owner would be required to pay. If the margin on direct outlay, the establishment charges and the net profit were agreed upon as a fixed sum, it would be an advantage to both owner and builder to keep the cost as low as possible. For since these items do not alter, the builder makes the same profit on a smaller turnover, while any reduction in the net cost of material and labor from the amount originally fixed reduces the cost of the vessel to the owner.

Such a system has been already carried out in practice by the Cunard Company in the case of the building of the *Franconia*. When it was arranged for that vessel to be built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., a contract was made in the usual way—that is, a fixed sum was agreed upon to complete the ship in a given time. When the contract was signed, it was suggested that the ship might be built on the principle outlined above, the price already quoted being considered to be the maximum sum payable by the owner. This course was agreed to, and the result of the experiment was that upon the completion of the contract the builders handed to the owners a rebate of $97,600 (£20,000) on the sum originally fixed. This gave satisfaction to all concerned, although to the uninitiated it might be imagined that it meant a loss to the builder. The reverse was actually the case, for the original profit named remained fixed and the rebate was accounted for in the savings on material and labor mutually agreed to during the construction of the ship.

In Table I, an attempt has been made to classify under convenient headings the total cost of building a ship. It will be noticed that the Contract Price has been divided into four general sections, namely:

1. Direct Outlay.
2. Establishment Charges.
3. Scheduled Items.
4. Builder's Profit.

The Contract Price would generally include all the work under these four headings, although the decoration of the public rooms included in Section 3 might be made the subject of a separate contract, and intrusted to a firm of decorators and carried out in accordance with the designs of an architect. In addition to the Contract Price, the incidental establishment charges incurred by the owner's staff in the performance of work connected solely with the building of the ship, such as salaries, traveling, office, and other expenses, as well as the cost of any items which the owners might themselves prefer to supply in order to complete either the equipment or outfit, would have to be added, in order that the whole estimated cost of the undertaking could be ascertained.

Taking these sections in order, it will be noted that the "Direct Outlay" is subdivided under three headings, namely, hull and outfit, machinery, and sundry fees and expenses. The cost of the hull and outfit is again subdivided under headings for materials, wages, and equipment and outfit. The cost of machinery is treated similarly, engines and boilers being each separately classified under the headings of material and labor: in the case of the engines the main and auxiliary portions are kept as separate items.

Under the heading of "Establishment Charges" have been classified various salaries and facilities, together with sundry items of year which the builder is bound to provide in order to keep his establishment open, and for the use of a proportion of which payment is due to him from his customers for the time being.

The "Scheduled Items" which form the next subdivision are those usually associated with sub-contracts which may, or may not, be carried out by subsidiary departments of the builder's establishment. The interpretation of the meaning of these items is generally a matter of considerable discussion, after the signing of a contract. It is in every way preferable for the owner to indicate, and to have allotted by the builder, a prime cost amount for each item tabulated. The cost named should be included in the builder's estimate, but the owners would ultimately pay an extra, or receive a rebate, according as the net cost to the builder is more or less than the sum originally allocated.

The inclusion, or otherwise, of the cost of the "Decoration of the Public Rooms" is a matter which would be determined by the nature of the work involved. In the case of the very elaborate schemes associated with large liners, this work is undoubtedly better placed in the hands of some firm of sub-contractors.

The succeeding Tables, Nos. II to V, serve to illustrate a manner in which the "Contract Price" might be determined in detail. The first sum which should be computed is the estimated cost of the builder's "Direct Outlay."

Dealing first with the cost of material, Table II outlines a method whereby the cost of the steel work and such material

TABLE II.—STEEL WORK.

| Method of Taking Out Quantity. | Items. Specifying fully the nature of Material, its position in ship, etc., etc. | Rate. Material. | Rate. Wages. | Cost. Material. | Cost. Wages. | Cost. Total. |
|---|---|---|---|---|---|---|
| By Weight..... | Steel plates, angles, rivets, castings, forgings, pillars, rails, expanded metals, etc., etc..... | | | | | |
| By Catalogue Prices | Bulkhead doors, manhole doors, etc., etc..... | | | | | |

can be determined, which is generally done on the basis of weight. Shell and deck plating would be dealt with first, and then such other plating as occurs throughout the structure. Thereafter, and in a systematic manner, the quantities of angle sections would be taken out. An estimate would be made for the weight of various classes of forgings and castings, based on previous experience with similar ships, and this, with all other quantities, would be subsequently revised when the items came to be weighed.

Table III deals with carpenter's wood, which will for the most part be taken out on a basis of superficial feet:

TABLE III.—CARPENTERS' WOOD.

| Method of Taking Out Quantity. | Material. Specifying fully class of timber, size, position in ship, etc., etc. | Rate. Material. | Rate. Wages. | Cost. Material. | Cost. Wages. | Cost. Total. |
|---|---|---|---|---|---|---|
| By Lineal Feet..... | Rails, sparring, etc..... | | | | | |
| By Super. Feet..... | Decks, ceiling, hatch covers gratings, wood bulkheads grain boards, etc..... | | | | | |

In the two foregoing tables the cost of material is kept separate from the cost of wages. In some cases, as, for example, in the manufacture and erection of cabins and cabin framing, furniture, painting, and other work, it is a convenient and easy matter to lay down rates for combined material and labor. The method suggested in Table IV indicates

TABLE IV.—JOINERS' WORK.

| Method of Taking Out Quantity. | Items. Fully specified, with position in ship and description of all work to be performed on same, including painting and erecting. | Rate, Material, and Wages. | Cost, Material, and Wages. |
|---|---|---|---|
| By Lineal Feet.. | Cants, head runners, architraves, cornices, moldings, rails, etc., etc..... | | |
| By Super. Feet.. | Framing, ceilings, etc..... | | |
| By Number Off. | Window boxes, beam casings, pillars, pilasters, doors, ladders, etc., etc..... | | |
| | Furniture in detail:— Sofas, toilet tables, night toilets, etc., etc..... | | |

such a treatment. If furniture were to be included the owner could name a price for the various items, and samples could be subsequently discussed and the price amended to suit.

As another example, Table V illustrates briefly the method of determining the cost of plumber's material:

TABLE V.—PLUMBERS' WORK.

| Method of Taking Out Quantity. | Items. Fully specified, with position or use in ship. | Rate. Material. | Rate. Wages. | Cost. Material. | Cost. Wages. | Cost. Total. |
|---|---|---|---|---|---|---|
| By Lineal Feet..... | Piping (all classes)..... | | | | | |
| By Weight..... | Couplings, bulkhead connections, cocks, scupper heads, rough castings, etc., etc..... | | | | | |
| By Number Off..... | Bends, traps, etc..... | | | | | |
| By Catalogue Prices | Various patent articles. ... | | | | | |

All the foregoing tables are intended to serve merely as indications of method, and should not be taken to represent a finished scheme. In the limits of such a paper as this no other treatment is possible, and an enormous amount of detail must necessarily remain undiscussed.

In some such perfectly feasible manner the whole cost of material alluded to under the heading "Direct Outlay" could be estimated, and a joint agreement come to with regard to the net sum involved.

The amount due for wages would then be taken out on the basis customary in the district. This can only be done after the amount of material has been determined. In such cases as those alluded to in Table IV no sum would be involved under this head, as the costs are derived on a basis which includes wages. The wages included under "Direct Outlay" are those of workmen directly employed in the construction of the ship, or working on machines while these are being used solely in this connection.

To an estimate such as this, it will be generally conceded that a positive margin of, say, 5 percent should be added, after a careful computation of the actual amount has been agreed to, in order to allow for errors and omissions. This margin should be added in when defining the cost of the "Direct Outlay."

A sum having been agreed upon as representing the Estimated Direct Outlay upon the ship, the Establishment Charges can be settled. These can be regarded as dependent upon the Direct Outlay, and it will be reasonable to assign for them a sum which is a certain agreed percentage of this amount. What percentage is actually to be taken must depend on the nature and amount of work to be performed, for it is easy to see that establishment charges may be greatly increased if any special facilities, such as additional cranes, piling and dredging, are required to carry out the work.

It is now possible to sum the three following quantities, namely: (*a*) The estimated direct outlay; (*b*) the establishment charges (a percentage of the direct outlay); and (*c*) the sum assigned by the owners to cover the cost of certain scheduled items, which sum the builder has to include in his estimate. The builder's profit is defined as some agreed percentage of the sum of the three items above. The exact percentage having been agreed upon, the contract price is fully determined.

The progress of the transaction should be watched by an auditor, whose function should be to ascertain and certify the amount actually expended by the builders, and to determine the interest; as well as by a quantity surveyor, who would become responsible to builder and owner for the measurement of quantities.

The actual sum to be paid to the builders, as opposed to the Contract Price, will be the sum of the four following quantities: (*A*) The actual certified amount of the direct outlay, provided always that this amount is not greater than the estimated sum (*a*); (*B*) the actual sum named above to cover establishment charges, namely (*b*); (*C*) the actual certified cost of the scheduled items; and (*D*) the actual sum named as the builder's profit, and of these (*B*) and (*D*) will remain as originally arranged. The cost under heading (*A*) will be revised in agreement with the investigations of the auditor and the quantity surveyor, and if, after investigation, the sum of the costs under this heading (*A*) is found to be less than the amount of the original estimate, the balance would be returned as a rebate by the builder to the owner.

Section (*C*) must be revised, and should the cost under this section exceed or be less than the scheduled amount, an adjustment would be made.

With reference to the method of payment, an agreement is generally entered into between the owners and the builder, in which the former undertakes to pay to the latter certain definite percentages of the contract price upon completion of various stages in the ship's construction, a certain final instalment being reserved until some period after delivery.

In the case of a big undertaking where the builder would be called upon to make exceptional outlay before the instalments reached him, and where the owner might have difficulty in laying his hands upon the necessary amount when the time for payment came, it might be desirable that an arrangement should be entered into whereby the owner could deposit with the builder a certain proportion of the money which would be due for payment in connection with the forthcoming instalment.

It is apparent that such a mode of contracting as is suggested in the foregoing remarks will stimulate the business capacity of the builder. The amount of profit and the amount paid to cover establishment charges are assured to him, and, consequently, it is to his interest to exert himself to keep down the actual charges. His risks are mainly taken when he is agreeing to contract rates for wages, but it is in his best interests, as well as in the interest of the country, that the cost of production should be kept as low as is reasonable if contracts are not to be placed elsewhere, and, consequently, a scheme which enforces him to constant activity in this respect is fundamentally sound.

The cost of meeting the requirements of post-contract legislation is obviously the subject of an extra-contract agreement between owner and builder.

Both of the above are risks which have not embarrassed

the successful working of such a system as has been outlined in the case of the building trades, or on those occasions when it has been applied successfully to the building of ships within the author's experience.

## Official Trials of the French Battleship Courbet

The battleship *Courbet* is a sister ship of the *Jean Bart*, described on page 288 of the June, 1913, issue of International Marine Engineering. The *Courbet*, however, is fitted with Niclausse watertube boilers, whereas the *Jean Bart* was fitted with Belleville boilers. The main particulars of the boilers of the *Courbet* are:

| | |
|---|---|
| Number of boilers | 24 |
| Total grate surface | 2,035 square feet |
| Total heating surface | 66,306 square feet |
| Working pressure | 256 pounds |
| Number of elements | 374 |
| Number of tubes | 9,724 |
| Length of tubes | 7 feet 11 inches |
| Inside diameter of tubes | 3 1/16 and 2 15/16 inches |
| Outside diameter of tubes | 3 5/16 inches |
| Mean diameter of funnels | 10 feet |
| Height of funnels | 65 feet 8 inches |

Preliminary trials of the *Courbet* were started on May 20, after the vessel had been placed in drydock and the hull had been cleaned and painted. The following month the vessel was sent to England with the President of the Republic on board, and the final trials were not carried out until July, and as there was no opportunity to dock the vessel and clean the hull again, the results obtained from the final trials were quite different from those obtained from the earlier trials.

Six-Hour Endurance Trial, May 20—

| | |
|---|---|
| Number of boilers in use | 12 |
| Pressure at steam chest | 35 pounds |
| Vacuum of condenser | 19.2 inches |
| Number of revolutions | 183.3 |
| Mean speed | 13.1 knots |
| Consumption per hour | 5 tons, 970 pounds |
| Consumption per mile | 901 pounds |

Ten-Hour Full-Speed Trial, May 28—

| | |
|---|---|
| Boilers in use | 24 |
| Pressure of boilers | 249 pounds |
| Pressure at steam chest | 152 pounds |
| Vacuum | 28.4 inches |
| Brake horsepower | 25,540 |
| Revolutions per minute | 290 |
| Mean speed | 20.803 knots |
| Contract speed | 20 knots |
| Consumption per hour | 23.569 tons |
| Consumption per mile | 2,495 pounds |
| Consumption at 20 knots, as per contract | 2,646 pounds |

Twenty-Four-Hour Trial, July 1 and 2—

| | |
|---|---|
| Boilers in use | 22 |
| Pressure at boilers | 229 pounds |
| Pressure at steam chest | 87 pounds |
| Vacuum | 28.84 inches |
| Revolutions per minute | 256 |
| Mean speed | 18.078 knots |

TWO VIEWS OF THE FRENCH BATTLESHIP COURBET TAKEN AT THE TIME OF HER OFFICIAL TRIALS

| | |
|---|---|
| Total consumption per hour | 13.495 tons |
| Consumption per mile | 1,660 pounds |
| Consumption per mile, as per contract | 1,808 pounds |

Three-Hour Full Steam Forced Draft Trial, July 9—

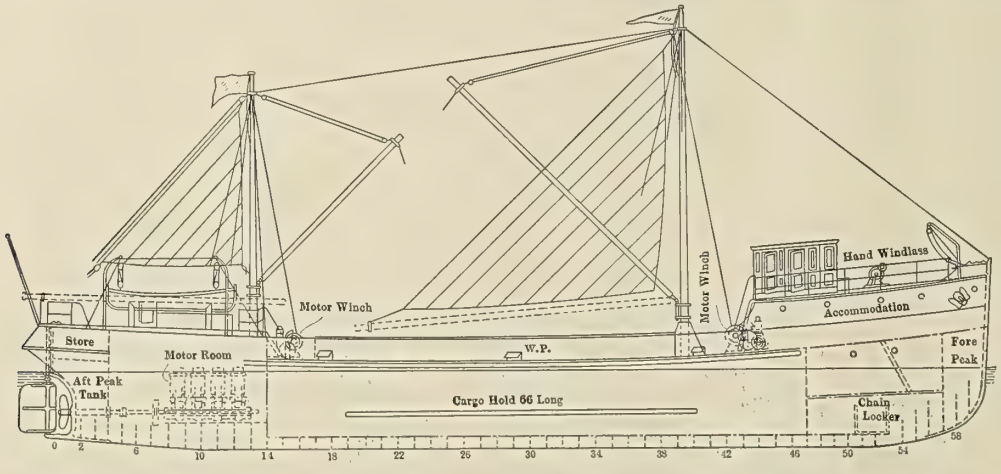
| | |
|---|---|
| Boilers in use | 24 |
| Pressure at boilers | 238 pounds |
| Pressure at steam chest | 169 pounds |
| Vacuum | 27.60 inches |
| Revolutions per minute | 296 |
| Mean speed | 20.737 knots |
| Total consumption per hour | 29.562 tons |
| Contract consumption per square foot of grate at 20-knot speed | 32.8 pounds |
| Consumption on trial at 20.737 knots | 32 pounds |
| Consumption per mile, as per contract, for 20-knot speed | 3,334 pounds |
| Consumption per mile on trial for 20.737-knot speed, | 3,157 pounds |
| Air pressure in boiler rooms | 0.88 inch of water |

Six-Hour Endurance Trial, July 16—

| | |
|---|---|
| Boilers in use | 6 |
| Pressure at steam chest | 26 pounds |
| Vacuum | 30 inches |
| Revolutions per minute | 127 |
| Speed | 9.396 knots |
| Total consumption per hour | 3.149 tons |
| Consumption per mile | 740 pounds |
| Consumption per mile, as per contract | 750 pounds |

## Motor Coaster of 400 Tons Deadweight Carrying Capacity

An interesting vessel which recently passed through her official trials is the 400-ton D. W. carrier *Innisshannon,* built for the Coasting Motor Shipping Company, of Glasgow, by Messrs. William Chalmers & Company, of Rutherglen. She is the first of four vessels for same owners, and is 115 feet between perpendiculars by 21 feet 6 inches beam by 10 feet 6 inches molded depth, and is designed to take her cargo on a draft of 9 feet 6 inches. While she is generally similar to the usual steam coaster in size, the *Innisshannon* has, nevertheless, one or two rather distinctive features. She has a single cargo hold amidships, and to allow of long-length cargoes being carried the hatchway is some 44 feet in length by 14 feet 6 inches in width.




THE FIRST OF FOUR 400-TON MOTOR COASTERS BUILDING FOR THE COASTING MOTOR SHIPPING CO. OF GLASGOW

The machinery space is aft, and here is installed a four-cylinder 220-brake horsepower Beardmore direct-reversible hot-bulb engine of the solid injection type. This engine, it is interesting to note, is the highest powered semi-Diesel to be built in Britain. Fuel to the extent of 2,800 gallons, or sufficient for three weeks' running, is carried in tanks situated in the engine-room. In the way of auxiliary machinery, there is an 8-brake horsepower Coats single-cylinder air-compressing and pumping set. Compressed air is used for starting up and maneuvering, and this is stored in two large reservoirs 6 feet 6 inches long by 3 feet diameter. For working the cargo, there is a two-ton Clarke Chapman motor winch at the mainmast and a one-ton Scandia motor winch at the mizzenmast.

A notable feature about the vessel is that the quarters for both officers and crew are situated forward, as also are the chart house and captain's cabin, which are in a small deck-house on the forecastle deck. *Innisshannon* will be used in the general coasting trade, and is expected to attain a speed on load draft of about 8¼ knots. She has been constructed to the British corporation's highest class.

On a series of runs over the measured mile on light draft, *Innisshannon* attained a mean speed of 9.16 knots.

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Motor Tank Ship Wotan.—The largest marine Diesel engine as yet installed in an ocean-going vessel is the 2,000-horsepower Carels six-cylinder, direct-reversible, two-cycle motor, built by the Reiherstieg Schiffwerft und Maschinenfabrik, of Hamburg, for the German-American Petroleum Company, and installed in their new tank ship *Wotan,* now on her maiden voyage to New York. The engine has cylinders 23½ inches diameter and 43¼ inches stroke, and is operated at about 90 revolutions per minute. The *Wotan* is 404 feet long, 52 feet 3 inches beam, 29 feet 6 inches depth, with a full-load draft of 23 feet. Her carrying capacity is 6,780 tons of oil in addition to 900 tons of bunker oil and 100 tons of water, making in all 7,780 tons. Sufficient fuel can be carried on this vessel for a voyage of 30,000 nautical miles. The auxiliary machinery on the vessel conforms in the main to the general practice in Carels Diesel-engined ships.

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## Declaration of Principles by the Business Press of America

The Federation of Trade Press Associations in the United States in eighth annual convention assembled at the Hotel Astor, New York, Sept. 18-20, 1913, made the following declaration of principles:

1. We believe the basic principles on which every trade paper should build is service—service to readers and service to advertisers, in a way to promote the welfare of the general public.

2. We believe in truth as applied to the editorial, news and advertising columns.

3. We believe in the utmost frankness regarding circulation.

4. We believe the highest efficiency of the business press of America can be secured through circulations of quality rather than of quantity—that character, and not mere numbers, should be the criterion by which the value of a publication should be judged.

5. We believe in co-operation with all those movements in the advertising, printing, publishing and merchandising fields which make for business and social betterment.

6. We believe that the best interests of manufacturers, the business press and consumers can be advanced through a greater interchange of facts regarding merchandise and merchandising, and to this end invite co-operation by manufacturers and consumers.

7. We believe that the logical medium to carry the message of the manufacturer directly to the distributor and the user is the business press.

8. We believe that while many advertising campaigns may profitably employ newspapers, magazines, out-door display, etc., no well-rounded campaign seeking to interest the consumer or user is complete without the business press.

9. We believe in co-operating with all interests which are engaged in creative advertising work.

10. We believe that business papers can best serve their trades, industries or professions by being leaders of thought; by keeping their editorial columns independent of the counting room, unbiased and unafraid; by keeping their news columns free from paid reading notices and puffery of all kinds; by refusing to print any advertisement which is misleading or which does not measure up to the highest standards of business integrity.

## Wreck Statistics for 1912

The statistical summary of vessels totally lost, broken up, condemned, etc., now published by Lloyd's Register, shows that during 1912 the gross reduction in the effective mercantile marine of the world amounted to 720 vessels of 748,965 tons, excluding all vessels of less than 100 tons. Of this total, 379 vessels of 572,745 tons were steamers, and 341 of 176,220 tons were sailing vessels. These figures are lower than those for 1911 by 135,878 tons (47,007 tons steam and 88,871 tons sail).

One of the most common terminations of a vessel's career is by breaking up, dismantling, etc. (not in consequence of casualty). The amount of tonnage so dealt with in 1912 was 157,641 tons, this being 97,876 tons less than that for 1911. Nearly 23 percent of the steamers and 24 percent of the sailing vessels removed from the merchant fleets of the world in the course of 1912 are accounted for in this manner, Of the total tonnage of such cases over 38 percent is represented by United Kingdom vessels.

The number and tonnage of vessels lost, etc., during the previous ten years are as follow:

| | Steamers | | Sailing Vessels | |
|---|---|---|---|---|
| Year | No. | Tons (Gross) | No. | Tons (Net) |
| 1902 | 301 | 408,363 | 571 | 292,327 |
| 1903 | 326 | 479,081 | 596 | 300,722 |
| 1904 | 344 | 512,879 | 463 | 225,266 |
| 1905 | 382 | 527,978 | 501 | 264,376 |
| 1906 | 378 | 509,707 | 567 | 307,105 |
| 1907 | 356 | 565,119 | 512 | 286,105 |
| 1908 | 382 | 566,487 | 418 | 242,805 |
| 1909 | 383 | 645,670 | 483 | 293,562 |
| 1910 | 421 | 667,440 | 442 | 280,250 |
| 1911 | 427 | 619,752 | 461 | 265,091 |

The statistical tables exhibit interesting data as to the relative frequency of the different kinds of casualty, etc., which conclude the existence of vessels. Strandings and kindred casualties which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualties are attributable over 54 percent of the losses of steamers, and over 55 percent of sailing vessels. Cases of abandoned, foundered and missing vessels are no doubt frequently more or less similar in the circumstances of loss. If these be taken collectively, they form over 24 percent of the steamers and over 29½ percent of the sailing vessels removed from the mercantile marine during 1912, owing to casualty.

The return has been prepared in such a manner as to enable a comparison to be made between the percentages of loss suffered by each of the principal merchant navies in the world.

(Photograph copyright by N. L. Stebbins) ARGENTINE BATTLESHIP RIVADAVIA AT FULL SPEED

## Trial Trip of the Argentine Battleship Rivadavia

The official builders' acceptance trials of the Argentine battleship *Rivadavia*, built by the Fore River Shipbuilding Corporation, Quincy, Mass., were carried out over the Rockland (Me.) measured mile course this month. The vessel is 585 feet long, 98 feet beam, designed for a speed of 22½ knots. The trial displacement of the ship is 27,600 tons and the full-load displacement 30,600 tons. The armament consists of twelve 12-inch guns, twelve 6-inch guns and sixteen 4-inch guns. The average of the high speed runs was slightly over 22.5 knots, the horsepower developed 39,750, and the revolutions 270 per minute. These trials were followed by gun trials, in which it was found that the structural portions of the ship withstood the shock of firing absolutely without injury. Further trials, consisting of a 30-hour run at 20 knots, a 30-hour run at 15 knots and an 8-hour run at 22.5 knots, will be conducted in the near future. The vessel will be delivered to the Argentine Government early in 1914.

# McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

## CHAPTER XIV
### Evaporators and Distillers

"Which one of you knows the difference between an evaporator and a distiller?" said McAndrew, at the commencement of the evening's lecture. Before any of the rest of the class could reply, the ever-ready O'Rourke blurted out, "One of 'em makes dried apples and the other makes booze."

"You are always talking about something that is most familiar to you, O'Rourke," sarcastically replied the instructor; "while it is true that 'booze' is distilled, we are dealing with water exclusively just now.

"You may remember that when we had the subject of boilers under consideration, I told you that nowadays only fresh water is used in the boilers. The steam from the engine is condensed over and over again and pumped back into the boilers; but in spite of all the precautions the engineer can take, there is more or less of the water lost on account of leakages around the boilers, at the pipe joints, and around the stuffing-boxes of the main engines and the auxiliaries. Just how much this leakage amounts to, it is hard to estimate, but a goodly supply of fresh water should be carried in the ship's tanks to make up the deficiency of feed. When that is used up, as it generally is after five or six days' steaming on most vessels, then we have to have other means for furnishing the fresh water. Of course, there is always as much salt water to be had as you may want, but the problem is to extract the solid matter from the sea water so that it will not be deposited on the heating surfaces of the boilers. For this purpose the evaporator is used, and you may as well understand that an evaporator is simply a boiler which uses steam to generate steam from sea water. The donkey boiler or one of the main boilers could be used for evaporating purposes but for the fact that the scale would be deposited on their heating surfaces, which are difficult to clean. Hence the most successful evaporator is the one that is easiest to clean. By using steam from the main boilers to generate steam in the evaporator, no fresh water is wasted, as the steam from the inside of the coils is condensed and passed back into the feed tank or condenser.

"The coils or tubes of an evaporator are usually arranged so that they can be pulled out or gotten at quite readily for cleaning purposes, for after only a day's use they are usually quite heavily incrusted with scale. Scaling evaporator coils at sea is a delightful job, and I am sure that you, O'Rourke, will be tickled to death to do your share of it."

"Huh!" said that worthy, "I have already done one trick at that business the last ship I was on. I worked so hard at it that I punched a hole through one of the coils, and the first assistant told me I was too strong for such scientific work."

"The chances are you did it on purpose to get out of work," said McAndrew, "but that shows you that care must be taken in scaling evaporator coils, as they are usually made of brass or copper, and, naturally, are as thin as they can well be made in order to better transmit the heat. The shell of the evaporator is made of steel, about the same as you would build a small boiler, only it is a good idea to add at least one-eighth of an inch to the thickness of the plate in order to allow for the excessive corrosion which always takes place around the water-line.

"There is quite a knack in running an evaporator, as you will find from experience. The principal thing to guard against is excessive foaming. If the water is carried too high in the glass, it will boil up and, mixing with the steam, will be carried over with it. For some reason the water in an evaporator foams more than it does in a boiler of the same size, hence its height must be watched carefully, and all evaporators should be fitted with baffle plates and dry pipes. If the distilled water is being run into a tank for the use of the ship, a little carelessness in allowing the salt water to lift might result in spoiling a whole lot of good drinking water.

"After the steam is generated in the evaporator, it is usually passed into the main condenser, where it is condensed into water along with the exhaust steam from the engine, and thus makes up the deficiency in the feed water."

"Where does this distilling business come in?" inquired Nelson.

"Oh, yes," replied McAndrew, "I almost forgot to tell you that on shipboard, as well as on shore, the distiller is used for drinking purposes, only that the ship's product is exclusively pure water. A ship's distiller is in reality only a small condenser, and is usually made of copper or brass; the sea water is used for cooling purposes, and, passing on the outside of a number of small brass or Muntz metal tubes, which have been carefully tinned, condenses the steam from the evaporator into fresh water, which is run into tanks and used for drinking or culinary purposes."

"I know all about the drinking end of it, but what's this 'culinary' stunt?" inquired O'Rourke.

"If you ever hung around the galley any, you must have noticed that the cook uses considerable fresh water to make coffee, soup, etc," replied McAndrew; "that's 'culinary'—perhaps I should have said 'cooking' purposes."

"Oh! I see," said O'Rourke; "the difference between 'culinary' and 'cooking' is about the same as the difference between a 'cook' and a 'chef.'"

"To return to the subject. I forgot to tell you that the feed water for the evaporator should not be taken from the sea direct, as it has to be heated up to the boiling temperature, so it is customary to take it from the discharge water from the main condenser, which has already been heated up to between 120 and 140 degrees; there is thus a considerable saving of heat units by using the discharge water instead of the cold sea water.

"Some ships have several evaporators in series, the steam in the first one being raised to 60 or 80 pounds pressure and then passed along to the next evaporator, where it is used to generate steam; the steam in the second evaporator is carried at a pressure of from 10 to 15 pounds, and this, in turn, is used to generate steam in a third evaporator, wherein the steam is sometimes at a pressure below that of the atmosphere, but it readily flows into the main condenser, where the vacuum is less. Such an apparatus is known as a triple-effect evaporator, and there is a considerable saving by such means. However, the first cost is so great that it is but seldom used.

"I must also tell you of a good wrinkle in scaling an evaporator where the coils are of the spiral type. A sudden change of temperature will tend to crack the scale, so that by a slight tapping with a wooden mallet it will drop off readily. To obtain this sudden change of temperature, the evaporator should be emptied of all water and steam turned on the coils until they are as hot as it is possible to get them. Then start your evaporator feed pump up as fast as it will run, open the bottom blow to the evaporator, and the valve connecting the evaporator to the main condenser, if there is a vacuum in it. The cold sea water will then rush in at such a rate as to give the sudden change in temperature desired. This effect can

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also be brought about by heating up the coils, taking off the lower manhole plate of the evaporator, if such is provided, and then turning the fire hose on the coils."

## CHAPTER XV

### Electricity

"One of the most important of the auxiliaries on board a modern steamer is the dynamo for generating electric current for lighting and ventilation purposes. The study of electricity presents a very large subject in itself, but it is essential that all marine engineers have at least a fair insight into the general principles involved. I will therefore give you a few hints on the subject which will, I hope, be of interest and benefit to you

"In commencing my remarks on the subject, I will ask if any of you know what electricity is?"

A silence followed this question, which was finally broken by O'Rourke, who said, "I did know once, but I have clean forgotten it."

"Too bad! Too bad, entirely," said McAndrew; "what a loss to the scientific world! To think that you once knew the mystic key to this great question which no living man has ever solved, and that you have forgotten it! You certainly should be punished for such monumental carelessness in keeping from the public the true answer to this hitherto unanswered problem. Well, we will have to continue in our ignorance, and although no one but O'Rourke has ever really known what electricity is, we, in common with all others, will have to devote our attention to studying its effects.

"The name 'electricity' comes from the Greek word 'electron,' meaning amber, as it was from rubbing this material with a catskin that the phenomenon was first noticed. There are three principal ways of generating this current, as it is generally termed. The first might be termed 'frictional electricity,' as it is generated by rubbing such substances as glass and silk together; you may also have noticed its effect by scuffing your feet on a woolen carpet and then touching some metal, such as a gas jet or brass bed, when you can generally see, hear and feel a slight electric shock. This method of generating electricity is not, however, used practically.

"The second method might be termed 'chemical electricity,' from the fact that a current is set up by immersing two different metals in a chemical solution. Copper and zinc are most commonly used, as it is found, when these metals are immersed in a mild solution of sulphuric acid, a pronounced flow of electricity is set up between them. This combination is known as a cell.

"A number of cells form a battery, and electricity from such a source is largely used for operating telegraph lines, alarm bells, etc. What are known as 'dry batteries,' wherein electricity is formed by the chemical decomposition of zinc in the presence of carbon surrounded by a paste made of plaster, flour or chemicals, are particularly useful on shipboard, as there is no liquid to be spilled by the rolling of the ship.

"The third method of generation might be termed the 'magnetic system.' You all know of and have played with the ordinary toy horseshoe magnet. The two ends of a magnet are known as 'poles,' and you no doubt have observed that there is an unseen force acting between these poles, sufficiently strong to attract or pick up small pieces of metal, and that it is particularly strong in picking up iron or steel. This ability of attracting pieces of metal is attributed to what are known as 'lines of magnetic force' which exist in the magnet. Some of the early experimenters discovered that if certain combinations of wires were revolved between these poles of a magnet —or the 'magnetic field,' as it is called—a current of electricity would be set up. Proceeding on this principle, the modern dynamo has been evolved. I will not attempt to mystify you by going into the theory of how this is done, as I feel quite sure that after I had finished you would probably have a hazier idea than you had before, so I will confine my remarks to some of the practical things which you should learn about the subject.

"This 'magnetic system' of producing electricity is used almost exclusively for all lighting and power purposes. The modern dynamo for producing current is to all intents and purposes a large magnet, and the bunches of wires revolving between its poles, and hence cutting the 'lines of force,' is known as the 'armature.' The current is collected by what are known as 'brushes,' generally blocks of carbon, held against the revolving metal.

"I do not expect you to grasp the idea of electricity immediately, as very few people do, but it will probably help you somewhat to compare it with water in a pipe system. In such a comparison we will consider the dynamo as a pump forcing water through a continuous line of pipe of varying diameter, according to the flow desired. We will suppose that the main leading away from the force pump is divided up into several branches, and that from each of these branches there are numbers of small spigots from which the water is being drawn. We all know that no water will flow from the outlets unless a pressure is put on by the pump. We also know that this water is being used at the various outlets, and that we can determine how many gallons per minute is being used if we so desire. You can also readily understand that the water will not flow through the pipe line as readily as it would if simply pumped overboard directly from the discharge valve, on account of the friction of the water as it slides or flows over the inner surfaces of the pipes. Now we must imagine that electricity is being used instead of water. The wires, proportioned according to the amount of flow required, take the places of the pipe and its branches. The electric lights, distributed along the branches, take the places of the spigots in the pipe line."

"The pressure of the water corresponds to what is known as 'electro-motive force' for electric currents, and the unit is known as the 'volt.' Thus we have on the switchboard of all electric plants a 'voltmeter,' which corresponds to the pressure gage in a pipe line; in other words, we read the electric pressure from the voltmeter, and it is well to note that the standard pressure for lighting currents on shipboard is 110 volts.

"The resistance to the flow of water through pipes corresponds to the resistance of the flow of electricity through wires, and the unit of this resistance is called an 'ohm.'

"The rate with which water flows through a pipe in a given time is expressed in so many gallons per minute; in electricity the rate of flow is expressed in a unit known as an 'ampere,' which means the amount of current produced by a pressure of one volt acting against a resistance of one ohm.

"Electric power, like mechanical power, must take into consideration the element of time, and the unit of this kind of power is known as the 'watt,' which is the power produced by a current of one ampere at a pressure of one volt for one second."

"Where do they get all these funny names like volt, ampere and ohm?" inquired Pierce.

"They are derived from the names of the early scientists who studied this subject, and in this way their fame will be handed down to future generations. Volt comes from the Italian named Volta, who was an early experimenter in the subject. Ampere was another early scientist, and you ought to know that Watt was the inventor of the steam engine. If you had been around in those days, and made the experiments, the unit of pressure might have been a 'pierce' instead of a 'volt.'"

"I'll bet," said Smith, "that the unit of resistance or friction would have been an 'O'Rourke' if he had been around in those days."

"One thing sure," replied McAndrew, "the unit of work—'ampere'—would never have been displaced by anything that sounded like an 'O'Rourke.'

"The 'watt' is a much smaller unit than the horsepower, and, in fact, it takes, theoretically, 746 watts to equal one horsepower. That doesn't mean that a one-horsepower engine would produce that many watts, as there are too many losses between the two, but it is known as the theoretical equivalent. In speaking of the rated power of a dynamo or generator, the general term is 20 K.W., 50 K.W., etc., as the case may be. The K. means kilo, the Greek word for one thousand, so that a 20 K.W. machine means one that is capable of producing 20,000 watts.

"To utilize electricity for lighting purposes, it was necessary to invent an electric lamp, and this fell to the lot of Edison, an American inventor, who, after many months of experimenting, found that a filament of carbonized bamboo, placed inside a glass bulb from which all the air had been exhausted, would heat up to an incandescence when an electric current was passed through it. If the air is not exhausted from the bulb, the oxygen in the air would cause combustion, which would burn up the filament almost instantly. Many metallic substances are now used for filaments, and are known as 'tungsten,' 'mazda,' 'tantalum,' etc. These are much more efficient than the old-style carbon-filament lamps, that is, they give much more light for the same amount of current used. The ordinary carbon-filament 16-candlepower lamp is generally used on shipboard; this lamp requires about ½ ampere of current or 55 watts. If we know the voltage of a current and the amperage, how do we tell how many watts will be used?" asked McAndrew of the class.

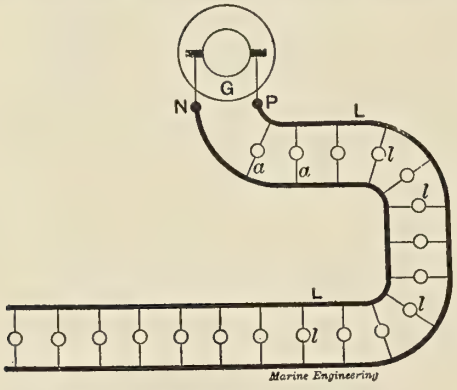



FIG. 24.—DISTRIBUTION IN PARALLEL

"Wait until you get the bill from the electric lighting company," suggested O'Rourke.

"You can't be too sure of that," replied the instructor, "as most people have an idea that gas bills and electric light bills are not made out on a strictly scientific basis. The right way to ascertain that fact is to remember that the watts are equivalent to the volts multiplied by the amperes. In this case we have 110 x ½, which equals 55. If we were using 20 amperes of current at a pressure of 10 volts the result would be 20 x 10, or 200 watts.

"An ordinary 16-candlepower lamp, using 55 watts of current, will require, on an average 1/10 horsepower at the generating engine, so I want to impress upon you the importance of turning off electric lamps which are not needed in any part of the ship, as they soon eat into the coal pile to a considerable extent, for every hour that a 16-candlepower lamp is burned there is nearly a pound of coal used under the boilers.

"I want to call your attention to the instruments used on the switchboard, which is the name of the apparatus by means of which the current is distributed. The whole electric light system is divided up into circuits or branches, corresponding to the different parts of the ship. For example, there is usually a complete circuit for the engine room, one for the fire room, one for the social hall, etc. If these were water-pipe connections there would be a valve in the pipes at both ends of the circuit. For electricity, what is known as a switch or cut-out is used, and generally located on the switchboard. They are usually of the double pole type, that is, they cut out both the sending side and the return side simultaneously.

"Unlike water, electricity is liable to sudden fluctuations of both pressure and volume; unless some means of easement is provided, damage is liable to result to the wiring or fixtures. Hence at various points in the circuit the current is made to pass through short lengths of some fusible alloy, which, when subjected to an unusual current, melts and breaks the circuit. These are made in two types, the link and cartridge; one is a plain wire, and the other is a wire encased in a fiber tube. The action in this case is similar in effect to the blowing off of a safety valve.

"The ammeter is an instrument for indicating by a needle on a dial the amount of current being used, which varies, of course, with the number of lights and fans in use.

"The voltmeter, or pressure gage, has the same function as a steam gage on the boiler.

"The rheostat is an instrument for using up surplus energy or current, and consists of a series of coiled wires which can be connected up in the circuit by moving a handle across the contact points. You probably know that when the main engine of a ship is required to run slowly, and the boilers temporarily making more steam than can be handled by the engine, it is customary to open what is known as the 'bleeder valve' from the main steam pipe, which allows the high-pressure steam to blow directly into the condenser. This is practically the same purpose for which the rheostat is used, the surplus current being dissipated by the increased resistance of the coils of wire which disposes of the electric energy in the form of heat.

"Now a word about wiring to transmit the current to the points where it is needed. As copper offers less resistance to the flow of electricity than any other metal of reasonable cost, it is used almost universally. In laying out the wiring for the ship, the sizes are determined to suit the quantity of electricity to be used in about the same manner that we would proportion piping for the distribution of steam or water. Small wires are made single, and for larger currents it is customary to use a number of small wires either parallel or laid up in the form of a cable. On shipboard it is of the first importance that the wires should be well insulated, that is, covered with a substance which prevents entirely, or to a large extent, any flow of electricity through it. The best and most used of such substances is ordinary rubber covered with braided silk or cotton to make the whole covering waterproof. Water is an excellent conductor of electricity, and hence any leakage through the covering on the wires will rapidly result in corrosion of the wires and leakage or short circuiting of the electric current. In the first marine electric installations the wires were run in wooden strips, but as it was difficult to keep them tight, the almost universal practice now is to run electric wires in iron pipes known as conduits. Porcelain is another excellent non-conductor of electricity, hence we find that material used for various kinds of electric fittings and lamp sockets.

"The wires for electric lights on ships are usually run in what is known as 'parallel,' as shown in Fig. 24.

"Each lamp, you will notice, is tapped off between the two wires, so that each will draw a sufficient amount of electricity from the main to run the particular lamp.

"Other uses than for lighting on shipboard are fan motors and winch motors."

"What is a motor?" inquired one of the class.

"A motor," said McAndrew, "is simply a small dynamo running backwards. Electric fans are driven by means of the current passing through the wire wound around the magnetic poles, which causes the armature to revolve. The fan blades are secured to an extension of the armature. If the small armature was made to revolve by an engine or other source of power, the motor would generate electricity instead of using it up, and hence become a small dynamo."

*(To be continued.)*

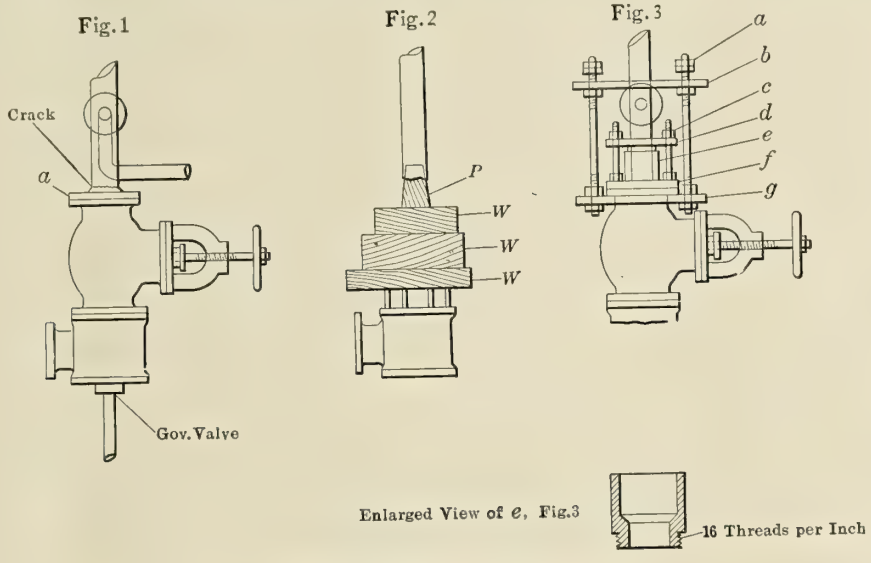
# Letters from Practical Marine Engineers

## Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

### Burst Steam Pipe

In the September, 1912, issue of International Marine Engineering appeared a description of the methods of repairing two breakdowns which occurred in a vessel equipped with a poorly-supplied storeroom. The following is an account of the way in which a burst steam pipe was repaired in another ship which was equipped with plenty of tools and materials.

Fig. 1 represents the throttle and governor valves, which were connected to one 26-kilowatt dynamo engine and one 2½-inch steam pipe. Another pipe was branched, as seen in the sketch. It supplied steam to a smaller dynamo.




METHOD OF REPAIRING A BURST STEAM PIPE

At 1 o'clock in the night, while running the main engines and the big dynamo at full speed, a sudden blow of steam was heard, followed by a sudden darkness throughout the whole ship. Upon inquiry, the cause was found to be that the steam pipe burst all the way around the neck of the flange connecting the pipe with the throttle valve. (See Fig. 1.) It disabled also the running of the smaller dynamo, so candles and oil bunker lamps were lighted.

But it was not altogether pleasant to stand night watches with that kind of light in a fairly big engine room, which is usually semi-dark at daytime, with the main engines running at full speed ahead and auxiliary apparatus here and there performing their respective duties, so we started to arrange the smaller dynamo to give us the required light temporarily.

First we removed the stop valve, together with the broken flange; then we plugged the steam pipe with wood. To have this plug securely fast several wood blocks were placed beneath it, and resting on top of the studs of the governor valve, as shown in Fig. 2. We had then all the light we wanted.

The next morning, and after a sort of a contest among the several engineers and electricians of the ship for the best idea for repairing the mishap, so as to enable both dynamos to furnish light and power for the machine shop all the time, we proceeded to carry into effect the scheme sketched in Fig. 3.

The center hole of the broken flange, now loose from the stop valve, was enlarged to 3 inches diameter, and sixteen threads cut inside. Part of one brass casting, 4½ inches diameter, was shaped in the lathe, as shown in the enlarged view of *e*, Fig. 3. This was screwed hard into the flange. Out of the remaining brass casting and one old brass flange found in the "junk pile," we made the corresponding gland (*d*, Fig. 3).

The joint of the throttle valve and the steam pipe flange was made before the breakdown by six ¾-inch bolts; three of these were removed and three studs of the required length with three nuts in each were fitted instead, so as to replace the removed bolts and drive the gland at the same time (Fig. 3, *c*). In order to prevent the movement of the steam pipe two pairs of clamps were forged from a flat iron bar ¼ inch thick by 2 inches wide. One was fitted to the neck of the stop valve (Fig. 3, *g*), and the other pair to the steam pipe, half an inch above the branching of the smaller pipe (Fig. 3, *f*). Two ⅝-inch stays (Fig. 3, *a*) were fitted afterward to hold the pipe down, and the upper nuts were slackened one turn and a half so as to allow for the expansion of the pipe.

The final result was what you might have called an expansion joint, and it proved entirely successful.

Manila, P. I. Augustus Suzara.

### Unlooked-for Stresses

The writer has frequently noticed cases where unconsidered stresses have produced quite unlooked-for results. As examples, the following two recent experiences may serve as illustrations and prove of interest to other readers.

The first case which the writer has in mind is that of a cast iron paddle center which was being replaced. It is much better to make these of cast steel, as it is tougher and better able to withstand the usage to which it is subjected, but as the original center was of cast iron the new one had also to be made of the same material.

In fitting these centers they are turned to a diameter slightly less than that of the shaft, and then driven on with a 28-pound hammer, removed and the hard places in the center

scraped down as indicated by the red lead bearings. Great care should be taken not to scrape away a false bearing.

It may be noted in passing that it is always advisable, in taking each bearing, to drive the center on the shaft twice, as the writer has frequently observed a difference of ¼ inch on driving it on the second time. When the job is finished and a good bearing obtained the center should still have ¼ inch to ⅜ inch to go until it is hard up against the shoulder turned on the shaft. This is to allow of being finally driven up with a "dolly" when the wheel is installed on the ship.

The center in question had been bedded in as usual and the allowance of ¼ inch for final driving on left, and then the arms were fitted and the wheel built up. On fitting the completed wheel in the ship it ran on to the shaft right up to the shoulder with the greatest of ease. The remedy was to chip ½ inch off the shoulder with a hammer and chisel and then file it up, as there was no time to remove the shaft again and do this in a lathe.

Naturally the cause of this strange phenomenon was sought after and it was suggested that the driving in of the paddle arms might have something to do with it. With this end in view wedges were driven into the recesses for the arms in the old center, the hole being carefully calipered before and after the operation. Though no actual measurements were taken, it was found that the hole was several thousandths of an inch larger after the wedges had been driven in than before, thus locating the cause of the trouble definitely in the building of the wheel.

Another case was that of a pad of a boiler stop valve. The pad, owing to some reason or other, had only been calked round half its circumference when the writer commenced to face up the pad and bed in the valve. The job was almost finished when a calker was sent to finish calking the pad. This he did, and on next trying on the valve we found that at the part of the circumference which he had just calked the pad had been raised up for about an inch in from its edge a distance of about a thirty-second of an inch.

This could quite easily have been avoided by calking the whole of the pad at one time, but the example serves to illustrate the forces brought into play in engineering, which are impossible to estimate.

Glasgow. "Ison."

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### Notes on Lubricating Oils

As the subject of lubricating oils is of great importance to marine engineers the following notes and simple tests may be of interest. To make a chemical analysis of the oil as it comes on board is, of course, impossible, involving, as it does, special apparatus and the expenditure of a good deal of time, hence only such simple tests are given as can be performed without spending much time on the job.

There are three classes of oils:

(1) Mineral oil.
(2) Animal oil.
(3) Vegetable oil.

And the chief properties which determine their suitability for lubricating purposes are: 1, the viscosity; 2, freedom from a tendency to gum; 3, freedom from acid. In some cases the flash point has to be taken into account, but this will be gone into later.

The value of an oil as a lubricant depends solely on its film-forming capacity, *i. e.*, its capability of maintaining a film of oil between the bearing surfaces. Film-forming capacity depends on the molecular cohesion, and also to a certain extent on the viscosity; but it must not be inferred from this that the oil of highest viscosity is the most suitable lubricant. To keep a bearing running cool it must have a good, durable oil film between the bearing surfaces, and the oil of lowest viscosity which will retain this oil film is the most suitable one for the purpose. Higher viscosity than is necessary to retain the oil film will result in a waste of power, due to the expenditure of energy necessary to overcome the internal friction of the oil itself. The viscosity of an oil for use in a certain bearing is dependent on the load carried; for example, a high-speed, light machine requires a thin oil, while a slow-running, heavy-duty machine is best suited with a thick oil, the thin oil having insufficient "body" to keep a good oil film between the bearing surfaces, and hence the bearings will heat up. Vegetable or animal oils are fairly suitable for external lubrication, but are apt to contain acids, due to the decomposition of the oil.

The following is a simple test for the viscosity of an oil: An ordinary glass burette fitted with a stop-cock is obtained and filled with water. The water is allowed to drip slowly through the tap and the number of drops per minute noted. The water is then removed, and without altering the setting of the stop-cock a sample of the oil under test is substituted. A similar test is then made. By this means some idea of the relative viscosity of oil may be obtained. The test is near enough for most practical purposes, but it must be remembered that the viscosity varies with the temperature.

For general purposes the following simple test is useful, but it must be remembered that it is not sufficient to judge a sample on the result of this test alone. Pour a few drops of each sample onto an inclined plate; the oil which remains fluid longest and runs farthest is the best.

The viscosity of oil can be varied by the addition of foreign substances, such as wax, resin, resin oil, etc. By adulterating a poor quality of mineral oil with resin or resin oil the oil may be made to resemble the superior quality, as regards density, viscosity, color and general appearance. The following two tests will serve to indicate whether an oil has been adulterated or not: Take a quantity of the oil and heat to a temperature of from 400-500 degrees F. If any fatty oil is present it will decompose before this temperature is reached, and its presence will be indicated by a bad smell. Another test for the detection of adulterants in mineral oil is to mix a portion of the sample with an equal quantity of fuming nitric acid. If at the end of a few hours the sample is still fluid it has been adulterated, and should not be used.

For internal lubrication only pure mineral oil of good quality should be used. Vegetable or animal oils are unsuitable, owing to the fact that they decompose at high temperatures, forming acids which are injurious to metals. Soot is also liberated, and the hard particles of carbon abrade bearing surfaces considerably. Mineral oil does not suffer from these drawbacks, as it has no effect on metals with which it comes in contact, and when vaporized does not decompose. If it is not wished to vaporize the oil it should be seen that its flash point is above the temperature of working. There are two tests for flash point: (1) the "closed" test; (2) the "open" test. The closed test requires special apparatus embodying a container to hold the oil fitted with a lid, which on being opened automatically depresses a small gas jet into the mixture of oil, vapor and air. The oil is heated gradually and the flame depressed into it at regular intervals of time. When an explosion is obtained the temperature is noted on a thermometer. An approximation to the true flash point may, however, be obtained by means of the "open" test, which simply consists in placing some of the oil to be tested in a suitable vessel and heating gradually, at the same time passing a flame over the surface of the liquid. A small high-temperature thermometer is, of course, placed in the oil to note the temperature at which the vapor ignites.

To find whether an oil contains an appreciable amount of acid, litmus may be employed

In conclusion, it may be noted that the following oils corrode the metals mentioned opposite them:

Tallow oil—Iron and copper.
Seal oil—Copper.
Whale oil—Lead.
Lard oil—Lead.
Sperm oil—Lead and zinc.
Rape oil—Copper.
Cottonseed oil—Tin. J. H. G. M.

### Leak Caused by Careless Boiler Maker

A bad case of pitting was found on board a steamship at the front end of the bottom of all three main boilers just above the knee plate, as shown on the sketch. A good layer of cement had been put on the inside, which lasted well until the ship came into port for repairs.

The boiler makers fitted a bent patch 5/8 inch thick over the end, as shown in the sketch, fitting bolts in places where the riveter couldn't swing his hammer. They had to cut the knee plate away to allow for the patch to fit in, which they jointed with some patent cement that proved useless after a while.

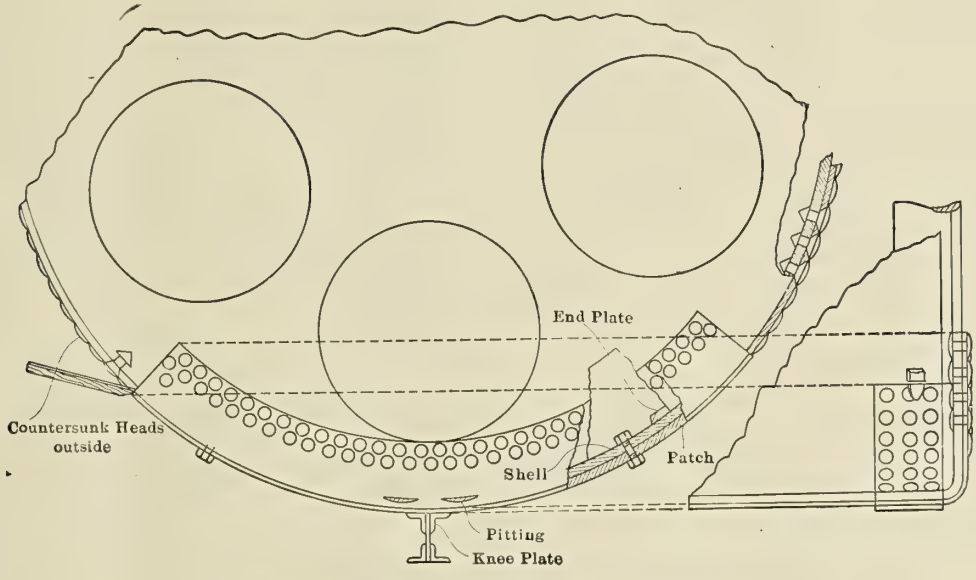
After the repairs had been made, and the vessel had been under steam three days, I had just gone down on watch one night, when one of the flat-faced Chinese firemen ran into the engine room, shouting, "Misses! Misses! too much puff! Plenty too much puff! Come! Look! See!" Well, I went to look, "see, see," as he called it, and found a great opening in one of the calked joints of a patch, as shown in the sketch. After calling the chief to see it, he went up to report to the captain, saying he would let the boiler down.

I went in the engine room to oil around, attend to matters, etc., and after a few minutes the same Oriental came in and said, "Misses, puff finish! You look, see! Yes, allight." When I got in the stokehold, I found they had sharpened the end of a piece of wood they had found about 5 feet long by 3 inches by 2½ inches, and hammered the wedge end in the blow hole, completely stopping all steam. They tried to look pleased at what they had done on their own initiative, but their faces wouldn't allow for the expression. The chief couldn't believe it would last without giving out, but it did for seven weeks. It did seem funny to us, under steam, with a great wooden chock rammed in one of our boilers.

However, when we did let the boiler down we found the end of a boiler maker's calking tool had been carelessly jammed between the patch and boiler plate and broken off, the man leaving it in without saying anything on the matter, and, of course, this piece of calking tool had blown out, causing "too much puff," as the fireman called it.

We hammered the patch up close, filled the joint with putty and recalked it.

I may say that when they had tested the boiler bottoms before fitting the patches, they found the plates pitted all in the one place, in the shape of a hollow the size of a man's hand. In some cases the plate was worn down to about one-eighth inch thick, yet 160 pounds pressure had been on the boilers the day before. To my mind, it is a good thing no heavy vibration of the furnace flues had taken place while under steam, or there might have been a serious accident. Needless to say, the boilers must have been a pretty old job to have reached that condition. R. Stein.




SKETCH OF FRONT OF BOILER, SHOWING POSITION OF PATCH

### A Reader's Comments on the Recent Contract for the Turbine Casings for the Battleship New York

It is, of course, quite possible that the current newspaper reports as to the placing in England of a contract for the turbine casings for the United States battleship *New York* may not be strictly accurate. In the press reports it is asserted in round figures that the English bid is $57,000 (£11,700) as against the lowest American bid of $160,000 (£32,800). These figures show such a surprising difference that it is certainly an interesting question to consider how such an enormous difference can be compatible with good business on either side of the Atlantic.

Work is undertaken, broadly speaking, for the three following reasons:

First, with a view of making money.

Secondly, with a view which disregards a profit but expects to make no loss. The advantage of being able to keep a well-organized force at work and not disintegrate it is an offset for lack of profit.

Third, a desire on the part of bidders to get a line on work which may be of advantage to them later. No hope of profit being entertained on the work, the loss is charged on the books to advertising, or whatever in the minds of the managers will show the loss the least conspicuously.

Now let it be understood that the standing of the New York house, as well as the English concern represented by them, is too high to admit of any supposition that the contract will not be absolutely carried out. From a pretty fair acquaintance of foundry conditions in England and the United States, it

is quite impossible to lay to the cost of material any but a small portion of the enormous difference in the bids. It must, therefore, come down to considering whether the foreign firm through its greater experience in the foundry can produce with far less risk such large and complicated castings than can be done here. This, coupled with the possibility of an infinitely better system of machining the castings, would of course count toward a far lower cost than is possible in any American engineering works for the job in hand.

It might be supposed by some that the American representatives of the English firm were not thoroughly cognizant of the close and exacting inspections which all work for the Navy has to undergo, but this idea can be immediately swept aside when it is understood that they have done business with the Government for years.

It is, therefore, only fair to assume that the English firm through its American representatives understand what they are about. If they expect to make money on the contract at the prices offered, it can be but a very small amount; or they may wish to keep their organization together while obtaining future contracts; or, finally, they may want to get a large proportion of the United States work with the hope of future profits. The statement that a duty will be collected has also been considered. As to the freights, there will probably be little or no difference between those from England and the United States.

On the other hand, in the several foundries of the United States able to undertake such large castings as these casings, many difficult pieces have been produced without unreasonable loss, yet the American foundries may have perhaps allowed too large a margin of safety, which would, of course, run up the price. Just what appliances the English firm has for machining casings cannot be stated here, but from a personal observation of those in the United States used for the boring part of the work, it is safe to say they could not be worse.

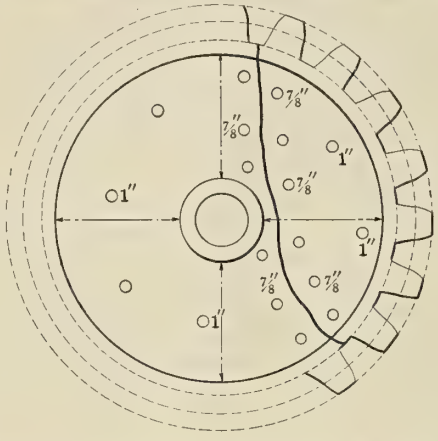
The machining of the casings is a job needing great care, but, after all, it is simply removing metal to an exact amount —no more, no less—and certainly the American machine shops have been able to do this creditably in the past. Of course, there will be the workingman's friend, raising his voice for protection for his fellow workman at so much "a profit," and there will be those who will show that every dollar sent out of the country is so much to the bad; those, too, who will be delighted that the idea has at last prevailed that an article should be bought in the cheapest market. Yet it will be interesting, indeed, to watch this contract, as it may be far-reaching in its effect by either showing that there is an absolutely absurd profit demanded by American manufacturers under the conditions of Government bids, or that our over-sea friends are running too close to the wind.

New York. W. D. Forbes.

### Broken Reversing Wheel

The steamship *B*———— had her reversing engines fixed on the two forward columns, each side, her shaft being amidships. On the end of the shaft was keyed a small pinion, which worked into a gear wheel of 4 feet diameter, whose shaft passed through the column at right angles to the reversing engines, which was fore and aft. From the wheel, and connected to the arm which in turn operated the shaft to which the links were connected, was a rod, whose center was 1 foot 3 inches from the center of the wheel, giving a travel of 2 feet 6 inches. This is a general outline of the arrangement of the reversing motion; but what I have to say is in regard to the gear wheel, which was 4 feet diameter, and solid cast iron with no arms. The thickness of the body was only half that of the width of teeth and the boss. Its shaft was of steel, 6 inches diameter.

During heavy weather on one trip this wheel broke in two parts, as shown in the sketch, due to racing and extra weight thrown on it from the reversing shaft and levers. The engine had to be stopped to effect repairs; the rod was lashed down by wire rope, with the blocks in the go-ahead position. After this was done the engine was started again, while we started to patch the wheel, as there was no spare one on board. A careful watch was maintained on the lashing by the engineer on watch while the assistants were busy on the wheel.




SHOWING THE CRACK AND PINS AND PORTION OF WORN WHEEL

Two plates were cut out of ⅜-inch plate (the thickest plate we could find) the diameter of the wheel under the rim, with a hole large enough in the center for the boss to come through. A number of holes were drilled in the two plates and the web of the wheel, to take 1-inch bolts and ⅞-inch bolts, the smaller holes being near the crack and more numerous. We bolted these two plates on each side of the wheel, making a good, solid job.

I may mention we were helped out a lot by having on board a hand-power drill press, which in a case of this sort was invaluable as regards time and labor.

The wheel when again in its place worked well and gave no trouble at all afterwards. H. W. Hankin.

Diesel-Driven Ship for New Orleans.—Very shortly a new large motor ship will be placed in service with New Orleans as a port of call. She is for the United Steamship Company, and will trade between New Orleans and Copenhagen, Denmark. She has been named *California,* and was launched at Messrs. Burmeister & Wain's yard Aug. 23. Of the awning-deck class she is 405 feet long between the inner-side of the stem and sternpost on the waterline, by 54 feet molded breadth, with 34 feet 11½ inches depth molded to the awning deck, and will have a deadweight capacity of 7,200 tons on a draft of 23 feet 3 inches. She is a twin-screw ship, and is fitted with two eight-cylinder reversible four-stroke type Burmeister & Wain Diesel oil engines, developing together a total of 2,700 indicated horsepower.

United States Battleship No. 39.—The United States battleship No. 39, which will be built at the New York navy yard, is similar in essential particulars to the U. S. S. *Pennsylvania,* now under construction by the Newport News Shipbuilding & Dry Dock Company. The length on the waterline is 600 feet; length over all, 608 feet; breadth, 97 feet ½ inch; draft, 28 feet 10 inches; displacement, 31,400 tons; speed, 21 knots; armament, twelve 14-inch guns; twenty-two 5-inch guns and four submerged torpedo tubes.

Correction.—In the description of the British battle cruiser *Tiger,* on page 290 of the July issue of this journal, it was erroneously stated that the vessel is fitted with Parsons turgines and Yarrow boilers. The *Tiger* is being built by John Brown & Company, and is being equipped with Curtis steam turbines and Babcock & Wilcox watertube boilers.

# Marine Articles in the Engineering Press

*The Wallsend-Howden System of Oil Burning in Marine Boilers.*—Supplanting a previous article describing the succession of experiments which led up to the burner now supplied by this firm, a description is given of an installation for the use of Mexican oil, as fitted to a vessel 541 feet 6 inches long overall, 527 feet between perpendiculars, 66 feet 6 inches beam, and 41½ feet depth to the shelter deck, with a deadweight carrying capacity of nearly 16,000 tons. The engines are of the quadruple expansion type, having cylinders 28½, 51, 58 and 84 inches in diameter with a stroke of 54 inches. The boilers, designed for a working pressure of 220 pounds per square inch, are single-ended, 16 feet 3 inches outside diameter and 12 feet long each with four Deighton furnaces. Details of the oil-burning installation are described with the aid of line drawings, and trial data are given showing a fuel consumption for all purposes of 1.034 pounds per indicated horsepower by the main engines, or for the propelling engines only .907 pound per indicated horsepower per hour. 7 illustrations. 700 words.—*Engineering,* July 25.

*The Port of Hamburg.*—By I. F. Bubendey. This article contains information taken from an address by the Director of the Port of Hamburg, made before the American Society of Mechanical Engineers during its visit to Hamburg June 24. The fact that the Elbe River is only 800 feet wide between the harbor works on both sides necessitated the excavating of large basins, in which there are at present available in the harbor 130,000 lineal feet of quays for ocean liners, more than 5,000,000 square feet of sheds and 805 cranes for loading and unloading vessels. The chief part of the harbor itself is outside of the German customs limits, and constitutes a free port, enabling the ships to come directly to the city without being examined by the custom house officers. The volume of maritime business at this port is shown by the fact that in 1912 18,500 vessels, representing more than 14,000,000 registered tons, arrived at the port. The sheds along the quays of Hamburg are not intended for storing goods for any considerable length of time. The cargoes taken from the ships are merely assorted there, to be conveyed promptly, either by boat or by rail, to the warehouses of the city or inland. The hoisting of the goods from the ship's hold is done by revolving jib cranes, of which 650 with an average lifting capacity of 3 tons are available. The oldest are operated by steam and the more recent ones by electricity. The cranes span the railroad track along the edge of the pier, and recently double cranes, consisting of a revolving jib crane, traveling on top of the pedestal from which a lower flange conveyor is suspended, were installed. The port of Hamburg is 65 nautical miles above the mouth of the Elbe River, and sixty years ago the channel of the Elbe had a depth of only 15 feet at high tide, but by steady dredging this depth has been increased at present to 37 feet, and will be deepened to at least 40 feet in a few years. At the present time there are sixteen State-owned dredges and six chartered dredges at work on the channel. In recent years an average of 8,000,000 cubic yards have been dredged annually, 9 illustrations. 1,800 words.—*Engineering News,* July 31.

*Screw Propellers.*—By Capt. C. W. Dyson, U. S. N. This article is a very comprehensive discussion of the subject of screw propellers from the point of view of the designer. It takes up the methods of design, design by comparison and the effect of thrust deduction and reduction of diameter on the propulsive coefficient. The article is accompanied by eight carefully prepared charts containing a vast amount of valuable data for use in the design of screw propellers. The author's formulas for computation of screw propellers are explained. 11 illustrations. 28,000 words.—*Journal of the American Society of Naval Engineers,* May.

*Photomicrographic Examination of Broken Crankshaft.*—To determine, if possible, the cause of failures in crankshafts, a photomicrographic examination was made of two broken crankshafts of the C-4. The specimens were taken from the shaft near the point of rupture, and were not of sufficient size to furnish specimens for physical tests, but were ample for microscopic purposes. Physical tests made when the shaft was manufactured were available, however. Three contributory causes for the failure of the shaft were suggested by this examination: (1) Excess of impurities; (2) poor heat treatment, and (3) fatigue. The impurities created weak planes in the material, making it possible for rupture to follow across the intervening bridges of normal metal from weak plane to weak plane. The abnormally large network unbalanced the metal. As far as fatigue is concerned, it appears from recent practice that chrome-vanadium steels have a higher value than nickel steels when compared from an anti-fatigue viewpoint. It is recommended that in the case of all important members, such as crankshafts, piston rods, etc., a microscopic record be made of the finished product, and these be filed as a part of the card history of the material. 4 illustrations. 2,500 words. —*Journal of the American Society of Naval Engineers,* May.

*Salt in Boiler Feed Water.*—By Ensign E. E. Wilson, U. S. N. This article points out the possibility of obtaining greater economy in steam boiler performance by maintaining a low degree of salinity in the feed water. The article begins with a consideration of the source of salt in boiler feed water as well as the methods of eliminating it. Salt may enter the feed system through leaky condensers, leaky distillers, leaky evaporator coils and leaky feed-water heaters, or careless operation of the evaporating plant may admit salt. Also salt may enter through feed connections to an auxiliary feed pump, through ash ejectors, through the feed pump taking a suction from a salty boiler, through the carrying over of a highly salty boiler or through leaky bottom blow valves of dead boilers. To prevent the entrance of salt from this source, the first requisite is an efficient water testing outfit, capable of determining the grains of chlorine per gallon to at least one grain. Comparison of performances of coal consumption of steam plants, although involving many conflicting factors, has shown that if an engineer watches the chlorine content of his boilers carefully a remarkable relation is found between the degree of salinity of the boiler water and the cost of operation of the plant, even when the chlorine contents varies within such narrow limits as from zero to 20 grains per gallon. Good results will certainly accrue from a careful investigation of the possibility of the absolute elimination of salt from the boiler feed water. 2,500 words.—*Journal of the American Society of Naval Engineers,* May.

*Screw Propellers.*—By Alfred J. C. Robertson, A. M. I. N. A., A. M. I. E. S. The author explains in this article how to deduce simple mathematical formulæ for designing a propeller of highest efficiency to conform to any special requirements. Acknowledgment is given to the value of exhaustive trials of model propellers made by such investigators as R. E. Froude, D. W. Taylor and Professor Peabody. As Taylor's work is available in book form, the author considers in this article only the work of Froude and how his results may be made use of. The author's diagram, derived from Froude's propeller results, together with his formulæ and examples worked out to illustrate their use, is given. 1 illustration. 1,800 words.—*The Shipbuilder,* September.

*The Efficient Maintenance of Turbine Machinery.*—By Lieutenant Revord. This article deals with the methods adopted to insure economical working, to maintain efficiency and to reduce the chances of breakdown with turbine engines.

The main points discussed are lubrication, vacuum, utilizing of exhaust steam in turbines, loss by skin friction, eddy current loss due to errors in workmanship or to insufficient blade velocity, unavoidable leakages, cavitation, the procedure adopted when raising steam in marine turbines, working adjustment of marine turbines, the dummy clearance, gaging the wear down of bearings, repairs, reblading rotor, reblading casing, procedure adopted in opening out turbines, precautions observed and breakdowns. The article is of a practical nature, and as it is based on extended practical experience with turbine machinery it is of corresponding value. 2 illustrations. 4,000 words.—*The Shipbuilder,* September.

*A New Method of Stopping a Vessel After Launching.*—By A. Hiley, A. M. I. N. A., A. M. I. C. E. The speed gained by a vessel before leaving the way-ends when launched generally averages from 15 to 20 feet per second. At first the resistance of the water to the vessel's motion is considerable, but this resistance decreases very rapidly at low speeds, and the vessel would travel from three to four times her length if opposed by the water resistance alone, whereas when a vessel is launched into a restricted breadth of water it is commonly found necessary to limit the travel to from 200 to 300 feet beyond the ends of the ways. A new form of friction launching brake is described, which it is proposed to use in place of the cumbersome drag chains usually employed for this purpose. In this brake the friction length employed is composed of two steel wire ropes. Springs tightened by screws produce the requisite pressure upon the ropes, which are gripped between grooves formed in two long steel castings. These steel castings remain stationary at an anchorage while the friction ropes are pulled through the grooves by the moving ship. The brake illustrated in the article is approximately equal in effect to 80 tons of chain drags and weighs itself but 2 tons. 4 illustrations. 875 words.—*The Shipbuilder,* September.

*The Quadruple-Screw Steamers Empress of Russia and Empress of Asia.*—These vessels were built by the Fairfield Shipbuilding & Engineering Company, Govan, for the Canadian Pacific Railway Company's passenger service between Canada and the Far East. The vessels are 590 feet long over all, 570 feet between perpendiculars, 68 feet molded breadth, 38 feet depth molded to upper deck, 20 knots' speed and 16,810 tons gross. The characteristic features in the external appearance of these vessels are the three funnels and cruiser stern. The article describes in detail the general arrangement of the vessels, interior decorations and appliances for handling freight, as well as the heating, ventilating, lighting and sanitary arrangements. Propulsion is by Parsons turbines, arranged in series on four shafts. Steam passes first to a high-pressure turbine on the port wing shaft, then to an intermediate-pressure turbine on the starboard wing shaft, and finally to two low-pressure turbines on the inner shafts. The astern turbines are incorporated with each low-pressure turbine. All of the turbines are arranged in a single room extending the entire width of the vessel, while the condensers and auxiliary machinery are arranged in a separate watertight compartment abaft the turbine room. Steam is supplied at 190 pounds working pressure by six double-ended and four single-ended Scotch boilers, having a total heating surface of 54,250 square feet and a total grate surface of 1,344 square feet. The trials of the *Empress of Russia* were carried out at Skelmorlie, with the vessel loaded to 26 feet 8 inches mean draft. The contract maximum requirements were exceeded by three-fourths of a knot, and on a 600-mile endurance run at sea an average speed of 20½ knots was obtained, or half a knot in excess of the contract requirement, with the coal consumption about 10 percent less than that guaranteed. 9 illustrations. 1,900 words.—*The Shipbuilder,* September.

*The Injury to the Hull of the U. S. S. Arkansas by Grounding.*—While the battleship *Arkansas* was proceeding at a speed of 12 knots from Guaycanaybo Bay, Cuba, to Guantanamo, at 6 o'clock in the evening of Feb. 11, 1913, the vessel struck bottom when drawing slightly over 25 feet forward and 28 feet aft. The obstructions undoubtedly consisted of uncharted coral pinnacles, which were apparently broken off by the ship riding over them, as the damages to the hull decreased toward the stern. A succession of shocks was felt on board the ship, and the vessel rolled first to one side and then to the other. The crew responded promptly to the call for collision quarters, and after all watertight doors and hatches were closed it was found that some twelve of the double-bottom compartments were leaking, although the water in several of these could be kept down by the pumps. The inner bottom held, and the leakage was confined practically to those compartments that were opened to the sea by the damage to shell plating and which were of comparatively small volume. The vessel came North to the Brooklyn navy yard without convoy and was floated into drydock No. 4. Examination of the bottom of the vessel showed that one pinnacle rock struck the bottom just under the port forward bilge keel, and distorting this badly forced in the shell plating in way of it. Another rock scraped along the bottom of the port side for over 200 feet, and for that distance made an indentation similar to an inverted trough, opening seams, tearing holes in the shell plating and buckling framing, brackets and longitudinals. On the starboard side a rock struck and caused similar damages for a distance of over 100 feet. That the damage sustained by the vessel as a whole was so comparatively small is attributed by the author to the excellent material and workmanship in the ship and the rigidity of the structure as designed. The repairs required involved the removal of twenty-eight shell plates, of which twelve were so badly damaged as to require replacement with new ones. Internal framing and brackets were badly buckled and broken, and had to be repaired by cutting out and renewing. While repairs were being made, special precautions were made to strengthen parts of the ship which showed signs of distortion on account of the removal of damaged portions. The behavior of the *Arkansas* under these damaged conditions is compared with that of the *Titanic,* and the inference is drawn that if the *Titanic* had been supplied with a double bottom extending completely over the underwater part of the hull the ship could have been saved. The efficiency of an inner skin having been thoroughly established, as far as the bottom of the ship is concerned, there is no reason to suppose that it would not be equally efficient as a protection for the sides of a ship. 5 illustrations. 1,500 words.—*Engineering News,* September 4.

*The New Spanish Battleships.*—The three new Spanish battleships—*España, Alfonso XIII* and *Jaime I*—all of which were built at the reconstructed Ferrol Arsenal by the Sociedad Española de Construccion Naval, are of the following dimensions: Length over all, 465 feet; length between perpendiculars, 435 feet; beam, 78 feet 9 inches; draft, 25 feet 6 inches; displacement, 15,450 tons; shaft horsepower, 15,500; speed, 19½ knots; radius of action at 10 knots' speed, 7,500 miles; armament, eight 12-inch 50-caliber guns; twenty 4-inch guns; six smaller guns. The main armor belt, extending for three-quarters of the length of the ship, is 9 inches thick, the strake above this is 6 inches thick, and the upper strake, 3 inches thick. The barbettes and gun hoods are protected by 10-inch armor, and the vital parts of the ship under the waterline are exceptionally well protected by longitudinal bulkheads 1½ inches thick. Propulsion is by Parsons compound turbines, driving four propellers at about 365 revolutions per minute. The propellers are of bronze, three-bladed, 7 feet 10½ inches diameter and 7 feet pitch. Steam is supplied at 235 pounds pressure by Yarrow large tube boilers, with a combined heating surface of 46,000 square feet and a grate area of 882 square feet. 10 illustrations. 3,000 words.—*Engineering,* August 8.

# New Books for the Marine Engineer's Library

Beeson's Marine Directory of the Northwestern Lakes. By Harvey C. Beeson. Size, 6¾ by 9¾ inches. Pages, 272. Numerous illustrations. Chicago, 1913: Harvey C. Beeson. Price, $5.00.

The main features of this book, which is now in its twenty-seventh year of publication, are the lists of American and Canadian steam and gas-engined vessels on the Great Lakes, the lake vessels whose names have been changed, the records of the engines and boilers and a section devoted to all the marine associations, both American and Canadian, on the Great Lakes. Interspersed among the tables are numerous items and articles, supplemented with illustrations relative to lake navigation and its growth, and marine affairs of importance the world over.

Worm Gearing. By Hugh Kerr Thomas. Size, 6 by 9 inches. Pages, 86. Illustrations, 33. New York, 1913: McGraw-Hill Book Company. Price, $1.50 net.

With the somewhat recent development of worm gearing in connection with the reduction gear of steam turbines for ship propulsion, the subject of worm gearing has become of increasing importance. This book will, therefore, be found of particular value to those who are concerned with this application of worm gearing, for it is practically the only book available in which a complete analysis of the principles of the design of worm gearing has been made. While a limited number of engineers may be familiar with the contents of the book, the data which it contains have not hitherto been accessible to the designer and draftsman in complete form.

The "Newest" Navigation Altitude and Azimuth Tables. Second Edition. By Lieut. Radler de Aquino (Brazilian navy). Size, 6 by 9½ inches. Pages, 268. London, 1912: J. D. Potter, 145 Minories, E. C. Price, 10/6 net.

The tables in this book were compiled by the author to form a simple and ready means for facilitating the determination of lines of position and geographical position at sea. The advance of this work over the existing tables for the same purpose consists in abridging the extent of the existing tables by tabulating the solutions of the two right-angle spherical triangles into which the astronomical triangle may always be divided. All sights for position are worked out by the same method without logarithms and with hardly any calculation. All other problems in navigation are easily and rapidly solved by inspection without interpolation.

Data Book for Shipbuilders and Naval Architects. By Pio Agapito. Size, 5⅝ by 8⅝ inches. Pages, 110. Trieste, Austria, 1913: Liberia Ettore Vram. Price, 2/6 in Austria; 2/10 abroad.

The author of this book, who is a naval architect, found in the course of his experience, as nearly every naval architect does, the importance of having a systematic form of tabulating data covering the design of various types of ships. To accomplish this end he has arranged in a remarkably clear and systematic form data sheets which have been printed and bound in book form, on which can be entered the principal dimensions, scantlings, capacities, etc., of vessels as well as trial data showing the performance of the vessels. At the end of the book a number of pages are printed with blank forms on which can be recorded the body plan offsets of vessels for guidance in future designs when drawings of a vessel are not available. This data book should prove of great value to naval architects who have not yet worked out a convenient form for recording construction data. A complete index should, of course, be added to such a book for reference purposes.

Steam Turbines: Their Theory and Construction. By H. Wilda. Size, 4⅝ by 7¼ inches. Pages, 191. Illustrations, 104. London, 1912: Scott, Greenwood & Son, and New York, 1912: D. Van Nostrand Company. Price, 3/6 net; $1.25 net.

In view of the many lengthy and exhaustive treatises on steam turbines, the appearance of such a small book as the one under review, which has for its subject theory and construction of steam turbines, is rather astonishing. The book is one of a series of engineering handbooks; but it can be classed as a handbook only in point of size, as the data which it contains and the treatment of the subject are exceedingly brief, while neither the illustrations nor the explanatory text give sufficient information about the details of turbine construction to be of practical value to an engineer. The part of the book which deals with the theory of steam turbines is especially limited in character, and can by no means be considered an adequate treatment of the subject.

Fighting Ships. Sixteenth Edition. Edited by Fred T. Jane. Size, 12½ by 7½ inches. Pages, 518. London, E. C., 1913: Sampson, Low, Marston & Company, Ltd. Price, 21/– net.

The 1913 edition of "Fighting Ships" is arranged in the same manner as in previous years, containing the main particulars of practically all the naval vessels in the world, arranged according to nationality in the order of strength. The leading sea powers appear in the same order as last year, Great Britain being first, Germany second, the United States third, Japan fourth, France fifth, Italy sixth, Austria seventh and Russia eighth. The Editor assures the readers that the greater part of the book is now placed upon an official revision basis and that the information given, while occasionally curtailed on account of the secrecy maintained by various Admiralties, is in the main free from errors which have appeared in previous issues, especially as regards the dimensions of docks and the details of private yards. The book is replete with excellent illustrations of various naval vessels, many of which are new. The second part of the book contains an interesting article by Charles de Grave Sells, M. Inst. C. E., on the "Progress of Marine Engineering." The subjects discussed in this article include turbines, reduction gearing, torsion meters, boilers, forced draft apparatus, valves, oil engines, hydro-aviation, submarine attack and submarine salvage.

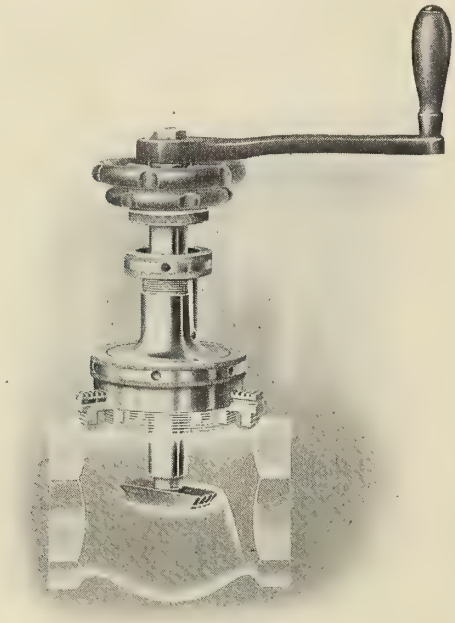
Engineering as a Profession. By A. P. M. Fleming, M. I. E. E., and R. W. Bailey, Wh. Sc. Size, 4¾ by 7½ inches. Pages, 288. London, 1913: John Long, Ltd. Price, 2/6 net.

Failure to win success in the engineering profession is many times due to a lack of knowledge as to what constitutes a suitable course of training and ignorance of the conditions governing engineering employment. A good engineer needs a good training and a knowledge of the limitations and possibilities of the field of work in which he enters. The question of co-relating the technical and practical portions of an engineer's training so as to secure the best results has been discussed at considerable length, but very little has previously been written regarding the facilities that actually exist for obtaining the most satisfactory training and employment. It is to supply this deficiency that this book has been written. It aims first at giving a broad, general outline of the field of engineering activity for the benefit of those who have only a popular conception of engineering matters, and a comparison is drawn between engineering and other well-recognized professions. The final chapters of the book take up the subjects of engineering appointments and foreign methods of training engineers.

## ENGINEERING SPECIALTIES

### The Improved Dexter Valve Reseating Machine

The improved Dexter valve reseating machine (Williams' patent), manufactured by the Leavitt Machine Company, Orange, Mass., is the result of many years' experience on the part of the manufacturers in specializing on tools for repairing valves. The model of the machine shown in the illustration is made in two sizes for reseating all flat and taper-seated valves, from ¼ to 3 inches and from ¼ to 4 inches. These machines, it is claimed, are positive in operation, as they true up a worn valve seat and its disk exactly alike, making a perfectly tight seat for water or steam. The illustration shows the machine attached to a globe valve with a taper cutter at work on the valve seat. An improvement in the jaws provides for securely attaching the machine to valves that have threads



on the outside of the body as well as for attaching to valves that are threaded on the inside and also for flanged cap valves.

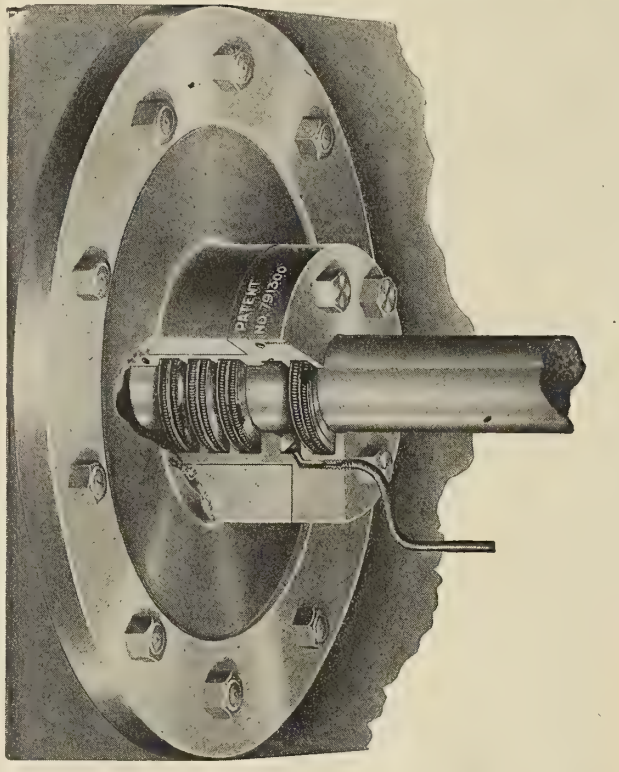
The operation of the machine is a simple matter. Its jaws are quickly adjusted to the valve casing by merely rotating the scroll of the chuck. This centers the machine and the tool spindle is placed in perfect alinement. A few turns of the handle and the seat is accurately recut, the entire job occupying only a few minutes. After the operation is finished, it is claimed, the valve is as good as new, and the same valve can be reseated from ten to twenty times, thus saving the cost of a new valve each time, and giving an opportunity to reclaim valves which have been consigned to the junk heap.

Some features of construction of this machine are distinct improvements. The bearing sleeve, which holds the tool spindle, extends through the chuck and is threaded on the inside of its upper end. These threads engage with the threads of the feed screw on the tool spindle. The bearing sleeve with the tool spindle slides through the chuck, and is instantly lowered to or raised from the valve seat, and is held in position by rotating the large nut shown on the body of the machine. The bearing sleeve supports the tool spindle practically its entire length, which not only strengthens the tool shaft but keeps it in perfect alinement regardless of the strain upon it, thus adding greatly to the life and usefulness of the machine.

The work of reseating the valve with the Dexter machine can be done by an ordinary mechanic without disconnecting the valve from the pipe line. Breaking connections and removing a valve because it leaks and putting in a new one is unnecessary and expensive, and frequently a source of trouble, for new valves may be leaky themselves. The value of this machine, therefore, for repairing leaky valves is apparent.

### The Holmes Metallic Packing

The Holmes Metallic Packing Company, Wilkes-Barre, Pa., manufactures a metallic packing which is made of the same material as the piston rings and the cylinder of the engines in which the packing is installed. As can be seen from the illustration, the packing is contained in a metal case made in halves, which is made to fit the stuffing-box for which it is designed. The case is securely screwed together and then pushed to the bottom of the stuffing-box. A joint is made of lead tubing at the bottom of the stuffing-box. The packing can be placed in the stuffing-box without disconnecting the




rod, and the operation can be performed in a very short time. Also, the packing can just as readily be removed from the box and taken apart when necessary.

The Holmes metallic packing is suitable for use on piston rods, valve stems, rotary valve stems, stop cocks, air pumps, compressors, or gas engines, as it is both steam and air-tight. It is claimed that the packing will not cut or score the rod, and when the engine is inactive it will not blister or rust the rod or stem. In other words, if the rod is in good condition when the packing is applied it will remain so and will not have to be turned when the engine is repaired.

A special feature of the Holmes packing, designed especially for marine work or for any engine where there is an excess of condensation, is the patent water-pocket packing, the construction of which is shown in the illustration.

### Ruins Removed by Oxy-Acetylene Apparatus

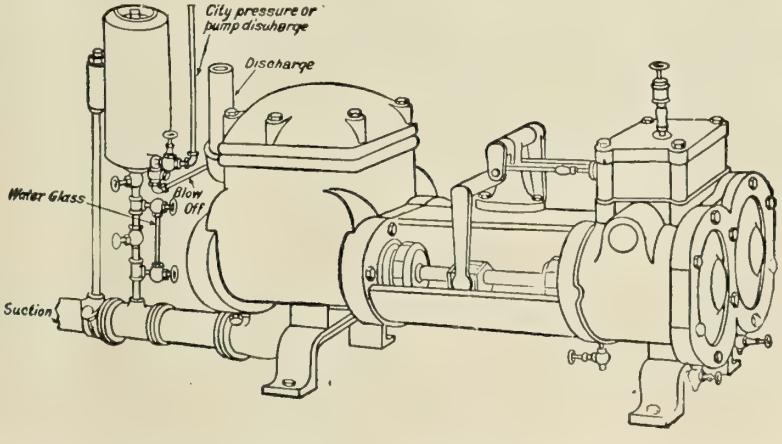
Early in January of this year the Carnegie Steel Company's plant in Baltimore, Md., was completely destroyed by fire, leaving a huge mass of buckled iron and steel twisted into every imaginable shape. Apparently it would require several months before this tangled mass of iron and steel could be cleared away, but by installing an oxy-acetylene welding and cutting

plant the twisted mass of iron and steel was cut into short, movable lengths, so that it could be hauled away in a remarkably short time. The plant installed for this work, supplied by the Alexander Milburn Company, Baltimore, Md., was mounted on a truck and moved from place to place as the work required. Fifty-foot lengths of hose were used, which gave a

fairly long range of work. The work progressed without trouble or mishap, and one operator and helper, with a single torch, were able to cut up the iron into movable lengths faster than a force of five men could load it on rail trucks and take it away.

### A Boiler Graphite Feeder

The illustration shows a graphite feeder furnished by the United States Graphite Company, of Saginaw, Mich., which is designed to accomplish a steady, gradual feed. This feeder has a reservoir which is so equipped with valves that it may be entirely closed and all water pressure shut off. The water valve is then opened so that the ordinary city water pressure is applied to the reservoir of the feeder and then this combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feed water onto the suction side of the pump. This valve, permitting the water saturated with graphite to pass through, can be readily adjusted by watching the water glass to see how fast it is traveling. With a little experience the engineer soon becomes able to regulate this valve so that there will be, through the hours of operation, a constant leeching of graphite going into




the boiler with the feed until the contents of the reservoir become exhausted, when the valves are again closed, and by means of a drain valve which is on the reservoir it is emptied of the clear water remaining in it and then again filled with graphite and regulated as before. After a little experience and measuring of time the valve through which the graphite passes into the feed water can be set and marked so that the engineer will know just where to open it each time in order to give his dose as specified. The illustration shows the manner in which the feeder is connected with the feed line at the suction side of the pump.

### The Donald Patent Elevator-Conveyor

Labor-saving appliances for loading or discharging ships are generally recognized as being more efficient when they can be operated continuously rather than intermittently. Only intermittent working is possible, however, with the usual ar-

rangements of cranes and derricks, which are commonly used at steamship terminals, and to improve such service the Donald elevator-conveyor has been placed on the market by Rownson, Drew & Clydesdale, Ltd., Upper Thames street, London, E. C. This conveyor is designed to save both labor and time in handling certain classes of miscellaneous cargo both for loading and unloading ships. It is so constructed as to work independently of the rise and fall of ships, due to the alteration in the water level or to cargo working. It can be raised or lowered to follow the cargo as the vessel is emptied or filled. The drive is preferably by a motor, of from 1 to 5 horsepower.

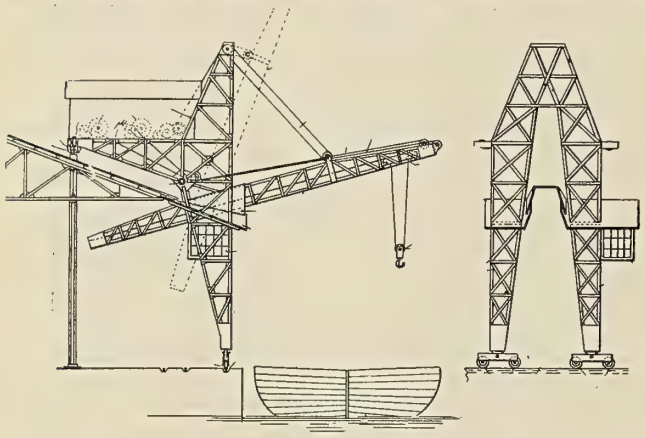
## SELECTED MARINE PATENTS

*The publication in this column of a patent specification does not necessarily imply editorial commendation.*

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,064,384. CARGO-HANDLING APPARATUS. HARRY SAWYER, OF MUSKEGON, MICHIGAN.

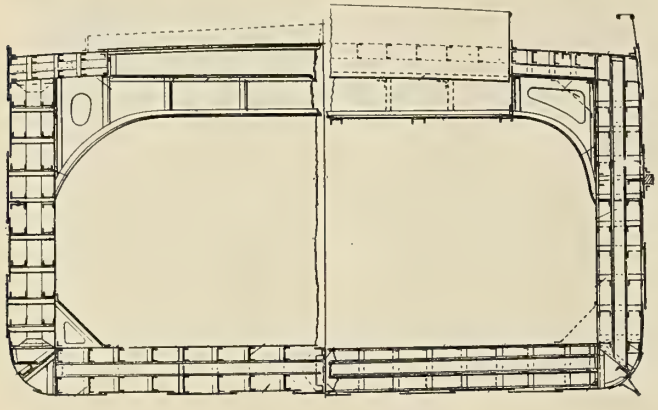
*Claim* 2.—A floor, an elevated structure erected thereon, a roof carried by said elevated structure, track rails respectively carried by the



floor and above the roof, a crane structure having portions respectively resting upon and operating along said track rails, and a roof section carried by said crane structure. Five claims.

1,066,039. SHIP CONSTRUCTION. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

*Claim* 1.—A steel ship or vessel, having inner and outer skins and comprising a plurality of longitudinal inner and outer spaced channel bar frames, transverse frames each comprising central channel bars extending across the bottom and sides between the inner and outer lon-



gitudinal frames, cross bars secured to the longitudinal and transverse frames and intercostal transverse bars filling the spaces between the central transverse frame bars and the inner and outer skins and secured thereto and to the transverse bars with angle bars and bracket plates. Eleven claims.

1,066,636. BUOY. THOMAS J. MACGENN, OF PORTLAND, OREGON.

*Claim* 2.—In a gas buoy having a gas chamber, supporting frame, gas burner and communicating pipes between said chamber and burner, the combination therewith of means pivotally supporting said burner, and a rudder resting in a vertical plane at right angles to the axis of said pivotal support for said burner, whereby to determine the position of said buoy relative to the movement of the water and to insure a plumb position for said burner. Four claims.

1,066,988. PROPELLER. WILLIAM R. BOUTWELL, OF NORFOLK, VIRGINIA.

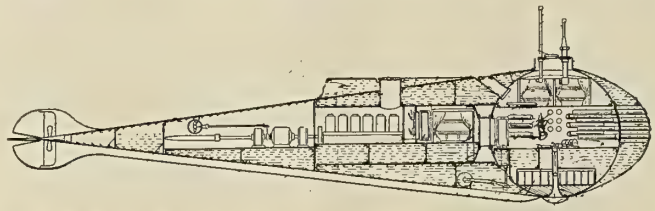
*Claim* 1.—In a propeller, the combination of a propeller blade having a number of perforations near its forward edge adapted to admit therethrough a small portion of the fluid propelled, said perforations being disposed at an angle directing the fluid against the back wash whereby to direct the latter between two adjacent propeller blades, and a diverting blade mounted upon the front face of said propeller blade and having one end located nearer the center of rotation than the opposite end thereof whereby to divert outwardly the flow of back wash against the front face of the propeller blade. Three claims.

1,067,207. SOUND-SCREEN. ROBERT L. WILLIAMS, OF NEWTON, MASACHUSETTS, ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

*Claim* 4.—The combination with a water containing tank, of a sound screen within said tank comprising a water tight casing having two or more solid walls or partitions inclosing between them one or more gas containing chambers. Five claims.

1,067,371. SUBMARINE OR SUBMERSIBLE TORPEDO-BOAT. EDWARD LASIUS PEACOCK, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY, OF BRIDGEPORT, CONNECTICUT, A CORPORATION OF NEW JERSEY.

*Claim* 1.—A submarine or submersible torpedo boat, having bow, amidships and stern sections, and an interposed substantially globular



hull section containing an interior compartment provided with torpedo expulsion tubes whose inboard or loading ends open within said compartment. Thirty-one claims.

1,068,276. BOAT-CHOCK. WILLIAM S. ROGERS, OF NEWPORT, RHODE ISLAND.

*Claim* 1.—In a boat chock, the combination of a main stationary member, a movable member supported normally thereupon, and means to control the movement and position of the movable member with respect to the stationary member, said means comprising a rock shaft journaled

upon both of said members and slidable along one of them, said rock shaft having at one end a crank interlocking with the end of the member along which the rock shaft is slidable. Two claims.

1,067,601. BELL-BUOY. JOHN GILLIS, OF THE UNITED STATES NAVY.

*Claim* 1.—A bell buoy provided with an anchored float, a framework on the float, a bell mounted on the framework, a revoluble shaft carrying a pulley and mounted on the said framework, a chain passing over the pulley and fixed at one end, a weight at the other end of the chain, an air compressor driven from the said shaft and discharging into the float, and a pneumatic hammer for sounding the bell and driven by the compressed air in the float. Nine claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

23,121. IMPROVEMENTS CONNECTED WITH SHIPS' STEERING GEAR. J. R. CLAY, OF BOOTLE, LANCASHIRE.

*Claim.*—In the steering gear of a ship in which the hand-operated part has a locking or preventive means connected with the hand-wheel pillar or stand, and is adapted to be operated by the navigator or commander, and comprises pawls and ratchet wheels; the invention consists in arranging such pawls so that they can be rocked on their pivots by the ratchet wheel which they work in connection with, when being revolved in and the required direction, without the movement of the lever, which moves them, or causes them to move into and out of action with their respective ratchet wheels and is actuated by the navigator or commander.

29,938. IMPROVEMENTS IN REINFORCED CONCRETE BARGES, LIGHTERS, ETC. N. K. FOUGNER, OF HONG KONG, CHINA.

*Claim.*—A vessel of the lighter barge type suitable for sea-work and built entirely of reinforced concrete, comprises a number of transverse frames of a suitable section and some of them continuous or ring-like formed or connected with several longitudinal parallel beams in the bottom, sides and deck, these beams at their ends converging towards the stem and stern posts of the vessel, stiffener beams diverging upward from the keel beams to the sides of the vessel, the stem and stern posts being vertical or slightly inclined outward, and watertight bulkheads at the transverse frames nearest the stem and stern. The ends of the vessel beyond the bulkheads may be formed with a solid reinforced deck having one small hatchway closed by a watertight hatch provided with means for battening it down to resist water pressure, thus forming a watertight compartment at each end of the vessel beyond the bulk heads.

13,742. IMPROVEMENTS IN THE CONSTRUCTION OF FLOATING VESSELS. J. W. ISHERWOOD OF LONDON, E. C.

*Claim.*—Improvements in the construction of floating vessels particularly applicable to, and advantageous in the "Isherwood" system, consist in attaching deck longitudinals above the deck plates and in locating the walls of cabins in line with the deep, strong, widely-spaced transverse Isherwood frames and beams, and the longitudinal deck beams, respectively.